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WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM FROM 1919 TO 1922, INCLUSIVE

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WEATHER CONDITIONS ON THE PROJECT[1]

CLIMATIC CONDITIONS IN 1919

The precipitation for 1919, 14.25 inches, was only 1.2 inches below the average for the 15-year period, 1908 to 1922, inclusive. The fall and winter months were unusually dry, and poor stands were obtained from late-seeded crops. The summer was hot and dry and very favorable for the production of alfalfa seed. The fall months were very unfavorable for field work, particularly for the harvesting of sugar beets and potatoes. In some cases these crops could not be harvested before the ground froze. Owing to the unfavorable weather conditions very little fall plowing was done on the project. The last killing frost in the spring occurred on May 13 and the first in the fall on October 8, giving a frost-free period of 147 days, which is 10 days more than the average for the 15 years ended in 1922.

[1] The Belle Fourche Experiment Farm includes 360 acres of land on the Belle Fourche Reclamation Project near Newell, S. Dak. Earlier reports have been published as follows: Bureau of Plant Industry Circular No. 119, issued March 29, 1913; unnumbered circular of the Office of Western Irrigation Agriculture, issued September 8, 1914, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1913"; W. I. A. Circular No. 4, issued August 28, 1915, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1914"; W. I. A. Circular No. 9, issued October 12, 1916, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1915"; W. I. A. Circular No. 14, issued September 22, 1917, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1916"; W. I. A. Circular No. 24, issued November, 1918, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1917," and Department Circular No. 60, issued September, 1919, "The Work of the Belle Fourche Reclamation Project Experiment Farm in 1918."

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CLIMATIC CONDITIONS IN 1920

The first part of the year 1920 was very nearly normal with the exception of the first week in March, which was very much colder than usual. There were 23 days of rain in April and 21 in May; consequently, the ground was in such condition that it could not be worked and little planting was possible until the last week in May, which is altogether too late for small grains in this locality. The weather in June continued cold, and with the excessive moisture in the ground conditions were very unfavorable for plant growth. During July and until the close of the season the rainfall was light, and conditions were very favorable for all farm work. The last killing frost in the spring occurred on April 29 and the first in the fall on September 25, giving a frost-free period of 148 days, which is 11 days more than the average for the period.

CLIMATIC CONDITIONS IN 1921

The winter months in 1921 were very mild and dry, but high winds blew the soil and caused much damage to the winter wheat. The spring was also very dry, and poor stands resulted. This was particularly so on spring-plowed land and ground that had previously been in alfalfa. The year was the driest with but one exception during the 15 years that records have been kept at the experiment farm, and frequent irrigations were necessary. Irrigation water was available at all times during the season. The fall months were very favorable for work. Grading and plowing were possible up to December 15. The last killing frost in the spring occurred on May 14 and the first in the fall on September 29, giving a frost-free period of 137 days, which is the same as the average for the period of record.

CLIMATIC CONDITIONS IN 1922

In 1922 the month of January was very cold. There was much more snow than usual during the month, the average precipitation for January for the 15-year period being 0.5 inch, while for 1922 the total was 1.31 inches. February was also colder than the average, and the snow stayed on the ground throughout the month. During March the weather was very mild, and field work was commenced about the 22d, but the last part of the month was cold and stormy. The first half of April was very unfavorable for field work and very little was done until the 21st, when general field work was resumed. The growing season was very favorable, although some difficulty was encountered in putting up the first cutting of alfalfa. The rainfall during July was well above normal, being 6.52 inches, as compared with the average for 15 years of 2.45 inches. This wet weather injured the quality of the grain. No irrigation was necessary until the first part of August, and from this time until November conditions were very favorable for the ripening of all the late crops and for field work of all kinds.

There was a frost-free period of 170 days, from April 19 to October 7. This is the longest frost-free period during the 15 years that records have been kept, the average frost-free period being 137 days. Table 1 presents a summary of the climatological observations made at the Belle Fourche Experiment Farm from 1908 to 1922, inclusive.

TABLE 1.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1922, inclusive*

PRECIPITATION (INCHES) [T=trace]

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Average for 15 years, 1908 to 1922	0.50	0.41	0.69	1.59	2.74	2.46	2.45	1.22	1.27	1.03	0.52	0.54	15.42
For 1919	.04	.57	.87	2.14	1.14	.35	2.59	1.02	1.20	2.49	1.22	.62	14.25
For 1920	.65	.16	1.35	2.59	8.35	5.90	2.53	.56	.63	1.67	.55	.95	25.89
For 1921	.29	T	.84	.72	1.44	3.36	2.30	.52	.72	.10	.30	.50	11.09
For 1922	1.31	.38	.20	2.84	3.42	3.74	6.52	.90	T	.79	2.82	.24	23.16

EVAPORATION (INCHES)

Average for 15 years, 1908 to 1922	------	------	------	3.95	5.45	6.92	8.15	7.13	5.05	------	------	------	36.69
For 1919	------	------	------	3.52	6.77	8.90	9.56	8.22	5.12	------	------	------	42.01
For 1920	------	------	------	1.81	3.99	4.79	6.45	7.04	4.83	------	------	------	28.95
For 1921	------	------	------	4.91	5.07	7.55	9.69	8.15	6.64	------	------	------	42.01
For 1922	------	------	------	3.48	6.05	6.15	5.75	7.10	5.86	------	------	------	34.39

WIND VELOCITY (MILES PER HOUR)

Highest:													
1908 to 1922	18.8	16.7	19.6	26.8	31.5	20.7	19.4	17.6	26.3	18.3	21.7	28.0	------
For 1919	------	------	------	19.1	18.3	13.7	12.2	11.9	9.3	------	------	------	------
For 1920	------	------	------	17.0	16.2	10.1	6.6	10.0	8.9	------	------	------	------
For 1921	------	------	------	22.7	20.4	13.5	10.5	11.1	15.0	------	------	------	------
For 1922	------	------	------	21.3	31.5	8.1	9.9	7.3	11.0	------	------	------	------
Lowest:													
1908 to 1922	.8	.8	1.7	.5	1.0	1.0	1.5	1.0	.9	2.1	.9	1.8	------
For 1919	------	------	------	2.3	2.7	3.3	3.1	1.9	2.2	------	------	------	------
For 1920	------	------	------	3.4	1.8	1.5	1.6	1.4	1.5	------	------	------	------
For 1921	------	------	------	3.4	1.0	3.3	1.8	1.0	2.9	------	------	------	------
For 1922	------	------	------	.5	2.0	1.6	1.5	1.3	1.2	------	------	------	------
Mean:													
1908 to 1922	7.2	6.6	7.5	8.2	8.4	6.8	5.5	5.2	5.7	6.7	6.0	8.4	------
For 1919	------	------	7.4	7.3	7.7	6.7	5.8	5.5	------	------	------	------	------
For 1920	------	------	7.3	8.0	4.8	3.2	3.9	4.3	------	------	------	------	------
For 1921	------	------	9.5	9.4	7.3	5.9	5.3	7.2	------	------	------	------	------
For 1922	------	------	7.2	9.5	4.3	3.9	3.9	4.1	------	------	------	------	------

MONTHLY TEMPERATURE (°F.)

Absolute maximum:													
1908 to 1922	64	62	87	89	95	108	109	105	105	92	78	66	------
For 1919	64	54	72	77	92	107	104	98	93	76	35	51	------
For 1920	51	51	65	64	81	94	101	98	94	95	59	54	------
For 1921	55	62	76	81	86	102	105	100	94	85	71	63	------
For 1922	39	49	67	78	82	95	94	96	95	92	55	49	------
Absolute minimum:													
1908 to 1922	−37	−36	−20	5	22	32	40	32	22	−7	−18	−31	------
For 1919	−21	−25	−9	12	31	32	49	42	33	−7	−7	−26	------
For 1920	−16	−10	−20	12	34	34	46	39	23	19	−5	−24	------
For 1921	−4	−8	6	9	25	47	45	39	29	18	−12	−17	------
For 1922	−25	−27	−11	19	34	36	42	46	36	14	11	−31	------
Mean:													
1908 to 1922	16	19	31	44	54	66	72	69	59	46	33	20	------
For 1919	29	18	31	43	56	70	75	71	61	35	23	17	------
For 1920	19	24	28	36	53	62	70	69	60	49	28	22	------
For 1921	26	30	35	44	54	70	74	71	59	51	30	22	------
For 1922	9	6	30	43	55	66	67	73	64	49	32	16	------

KILLING FROSTS[1]

Year	Last in spring	First in fall	Frost-free period (days)	Year	Last in spring	First in fall	Frost-free period (days)
1908	May 20	Sept. 26	128	1917	May 31	Oct. 7	128
1909	May 17	Sept. 23	128	1918	May 21	Sept. 18	119
1910	May 23	Sept. 25	124	1919	May 13	Oct. 8	147
1911	May 11	Oct. 3	144	1920	Apr. 29	Sept. 25	148
1912	Apr. 21	Sept. 24	155	1921	May 14	Sept. 29	137
1913	May 4	do	142	1922	Apr. 19	Oct. 7	170
1914	May 12	Oct. 4	144				
1915	May 17	Sept. 14	119	15-year average			137
1916	May 16	do	120				

[1] A temperature below 32° F. is considered a killing frost.

CROP CONDITIONS

Irrigation water was first delivered on the Belle Fourche project in a limited way in 1909 from the Johnson lateral, and to some extent from the South Canal. The North Canal and its laterals were completed as far as the town of Newell and thence to the mouth of Horse Creek in 1911, and all Government lands within this district were opened for filing in 1912. The North Canal and laterals were continued to Willow Creek and south to the Belle Fourche River in 1915, and this unit, including all irrigable lands, was opened that year.

The total irrigable area of the farms on the Belle Fourche project from which crop yields were reported for 1912 was 44,654 acres, included in 537 farms. Of this area 27,617 acres were actually irrigated. In 1922 the total irrigable area of the project was 72,748 acres, included in 1,035 farms. Of this area 3,306 acres are classed as seeped land and exempt from water charges. The area from which crops were harvested in 1922 was 56,928 acres.

The acreage, yields, and farm values of the crops produced on the project in 1922 are shown in Table 2, the figures being obtained from the printed reports of the United States Reclamation Service.

TABLE 2.—*Acreage, yields, and farm values of the crops produced on the Belle Fourche Reclamation Project in 1922*

[Each number marked with an asterisk (*) is only an approximation]

Crop	Areas (acres)	Unit of yield	Yields				Farm values		
			Total	Per acre			Per unit of yield	Total	Per acre
				Average	Maximum	Minimum			
Alfalfa hay	28,965	Ton	48,460	1.67	4.0		$5.00	$242,300	$8.35*
Alfalfa seed	883	Bushel	739	.84	6.0		9.80	7,242*	8.23*
Barley	1,284	do	25,511	19.90*	68.0		.45	11,480*	8.94
Beans	3	do	50	16.70*	30.0	10.0	2.40	120	40.00
Beets, sugar	324	Ton	3,145	9.70*	15.0		5.00	15,725	48.50*
Corn	7,130	Bushel	177,720	25.00*	60.0		.56	99,523*	13.96
Corn fodder	103	Ton	219	2.12*	5.0	.7	10.00	2,190	21.25*
Flax	19	Bushel	80	4.20*	5.0	4.1	2.50	200	10.53
Garden	171							11,260	65.85
Hay, grain	205	Ton	148	.72*	1.3		5.00	740	3.67*
Hay, native	2,388	do	2,401	1.00*	2.3	.4	7.00	16,807	7.00*
Oats	5,050	Bushel	133,261	26.00*	90.0		.32	42,643*	8.42*
Pasture, alfalfa	5,230						7.00	36,617	7.00
Potatoes	311	Bushel	30,271	97.00*	400.0		.60	18,162*	58.20*
Sweetclover seed	95	do	200	2.10*	5.7		9.00	1,800	18.94*
Sweetclover hay	214	Ton	212	.99*	2.0		5.00	1,060	5.00*
Wheat	5,482	Bushel	85,288	15.5*	40.0		.90	76,759*	14.00
Miscellaneous	29							999	34.45
Less duplicated areas	963								
Total or average	56,928							585,627	10.28*

During the early years of the project, the small grains were the principal crops grown. In 1913 some 13,000 acres were planted to wheat and 7,000 acres to alfalfa, about two acres of wheat to one of alfalfa, while in 1922 some 30,000 acres were in alfalfa and 5,000 in wheat, about one acre of wheat to six of alfalfa. The maximum production and farm values were obtained in 1919, but these values were due to the increased prices of all crops, particularly alfalfa hay, rather than to any appreciable increase of production or better farming methods.

Table 3 shows the acreage, production, and farm values of the principal crops grown on the Belle Fourche Reclamation Project from 1913 to 1922, inclusive, the figures being taken from the printed reports of the United States Reclamation Service.

TABLE 3.—*Acreage, production, and farm values of the principal crops grown on the Belle Fourche Reclamation Project, 1913 to 1922, inclusive*

Item and year	All crops[1]	Alfalfa hay	Alfalfa seed	Barley	Corn	Native hay	Oats	Pasture	Wheat	Sugar beets
Acreage:										
1913	32,568	7,388	1,576	744	1,859	2,533	5,343	285	13,096	-------
1914	36,709	9,745	1,416	1,448	4,415	2,236	6,392	3,604	7,885	-------
1915	43,063	16,152	284	1,613	4,470	2,782	4,440	3,273	7,747	-------
1916	46,909	17,945	4,177	2,740	3,846	2,121	4,119	6,132	7,554	-------
1917	50,026	19,702	942	2,286	2,902	4,475	4,955	6,100	5,122	-------
1918	52,445	20,467	342	1,636	2,068	3,209	4,331	8,894	9,563	-------
1919	56,255	24,804	842	1,351	2,903	3,290	3,665	6,922	10,742	978
1920	59,850	26,040	752	1,695	3,272	2,820	4,864	8,390	9,850	1,103
1921	55,100	25,829	1,810	1,423	5,622	940	5,390	7,352	5,341	926
1922	56,920	28,965	883	1,284	7,130	2,388	5,051	5,230	5,482	324
Production:		*Tons*	*Bush.*	*Bush.*	*Bush.*	*Tons*	*Bush.*		*Bush.*	*Tons*
1913	-------	15,854	2,157	18,101	35,615	2,232	161,765	-------	195,205	-------
1914	-------	20,473	3,305	34,718	106,280	1,911	209,813	-------	108,880	-------
1915	-------	34,842	65	47,365	64,098	2,507	165,260	-------	133,248	-------
1916	-------	36,765	5,320	42,804	75,588	1,749	91,767	-------	38,222	-------
1917	-------	35,692	2,335	55,164	46,290	3,108	106,309	-------	67,095	-------
1918	-------	42,032	362	40,775	43,830	3,610	137,066	-------	152,674	-------
1919	-------	54,928	1,795	44,897	63,756	3,468	78,284	-------	119,707	10,537
1920	-------	48,734	162	25,744	62,589	2,974	112,022	-------	49,815	10,291
1921	-------	43,238	1,208	18,850	110,420	701	88,600	-------	54,880	10,256
1922	-------	48,460	739	25,511	177,720	2,401	133,261	-------	85,288	3,145
Average yields per acre:										
1913	-------	2.1	1.4	24.3	19.1	0.9	30.3	-------	14.9	-------
1914	-------	2.1	2.3	24.0	24.1	.9	32.8	-------	13.8	-------
1915	-------	2.2	.2	29.3	14.3	.9	37.2	-------	17.2	-------
1916	-------	2.0	1.3	15.6	19.6	.8	22.1	-------	5.1	-------
1917	-------	1.8	2.5	24.2	15.9	.7	21.5	-------	13.1	-------
1918	-------	2.0	1.0	24.9	21.2	1.1	31.7	-------	15.7	-------
1919	-------	2.2	2.1	33.22	21.9	1.0	21.5	-------	11.1	10.8
1920	-------	1.9	.22	15.2	19.1	1.0	23.0	-------	5.1	9.3
1921	-------	1.7	.7	13.2	19.6	.7	16.4	-------	10.3	11.1
1922	-------	1.7	.8	19.9	24.9	1.0	26.0	-------	15.5	9.7
Farm values per unit of yield:										
1913	-------	$4.50	$6.00	$0.60	$0.80	$10.00	$0.40	-------	$0.60	-------
1914	-------	4.50	7.30	.70	.70	10.00	.40	-------	.90	-------
1915	-------	4.50	10.00	.65	.50	10.00	.40	-------	.80	-------
1916	-------	7.00	8.00	.70	.80	9.50	.40	-------	1.25	-------
1917	-------	15.00	8.00	1.25	2.00	16.00	.70	-------	1.90	-------
1918	-------	12.00	9.00	1.00	1.40	18.00	.70	-------	1.90	-------
1919	-------	20.00	15.00	1.50	1.50	25.00	.80	-------	2.20	$10.00
1920	-------	8.00	15.00	.45	.75	8.00	.45	-------	1.75	10.50
1921	-------	5.00	12.00	.40	.50	6.00	.32	-------	.90	5.50
1922	-------	5.00	9.80	.45	.56	7.00	.32	-------	.90	5.00
Farm values per acre:										
1913	$10.91	9.66	8.21	14.60	15.33	8.81	12.11	$6.98	8.94	-------
1914	12.56	9.45	16.52	16.78	16.85	8.55	13.13	3.35	12.43	-------
1915	10.73	9.71	2.29	19.09	7.17	9.01	14.89	4.31	13.76	-------
1916	11.88	14.34	10.19	10.94	15.72	7.83	8.91	4.54	6.32	-------
1917	23.41	27.17	19.83	30.16	31.90	11.11	15.02	10.94	24.89	-------
1918	24.33	24.64	9.53	24.92	29.67	20.25	22.15	5.83	30.33	-------
1919	34.89	44.29	31.98	49.85	32.94	26.35	17.08	12.73	24.51	107.74
1920	13.90	14.97	3.23	6.83	14.35	8.44	10.34	8.00	8.85	97.96
1921	9.32	8.37	8.01	5.30	9.82	4.47	5.26	5.00	9.23	60.92
1922	10.29	8.37	8.20	8.94	13.96	7.04	8.42	7.00	14.00	48.53
Total farm values:										
1913	355,380	71,343	12,942	10,861	28,492	22,320	64,706	1,990	117,123	-------
1914	461,188	92,129	23,397	24,303	74,396	19,110	83,925	12,078	97,992	-------
1915	462,050	156,789	650	30,787	32,049	25,070	66,104	14,105	106,598	-------
1916	557,319	257,355	42,560	29,963	60,470	16,615	36,707	27,826	47,778	-------
1917	1,171,239	535,380	18,680	68,955	92,580	49,728	74,416	66,709	127,480	-------
1918	1,276,115	504,384	3,258	40,775	61,362	64,980	95,946	51,879	290,080	-------
1919	1,962,683	1,098,560	26,925	67,345	95,634	86,700	62,597	88,134	263,355	105,370
1920	832,200	389,870	2,430	11,580	46,940	23,790	50,410	67,130	87,170	108,055
1921	513,750	216,190	14,496	7,540	55,210	4,202	28,352	36,760	49,295	56,408
1922	585,770	242,430	7,242	11,480	99,526	16,807	42,643	36,617	76,759	15,725

[1] Less duplicated areas.

Table 4 shows the annual and average production and farm values of the principal crops grown on the Belle Fourche project from 1913 to 1922, inclusive, the figures being obtained from the printed reports of the United States Reclamation Service.

TABLE 4.—*Annual and average yields, values per unit of yield, and returns per acre of the principal crops grown on the Belle Fourche Reclamation Project in stated years*

Principal crops	Unit of yield	Annual and average yields			Annual and average values per unit of yield			Annual and average returns per acre		
		1914	1913–1922	1922	1914	1913–1922	1922	1914	1913–1922	1922
Alfalfa hay	Ton	2.1	1.97	1.7	$4.50	$8.55	$5.00	$9.45	$17.10	$8.37
Alfalfa seed	Bushel	2.3	1.25	.8	7.30	10.01	9.80	16.52	11.80	8.20
Barley	do	24.0	22.28	19.9	.70	.77	.45	16.78	18.74	8.94
Corn	do	24.1	19.97	24.9	.70	.95	.56	16.85	18.77	13.96
Native hay	Ton	.9	.92	1.0	10.00	11.95	7.00	8.55	11.26	7.04
Oats	Bushel	32.8	26.24	26.4	.40	.49	.32	13.13	12.74	8.44
Wheat	do	13.8	12.18	15.5	.90	1.31	.90	12.43	15.33	14.00

The crop yields in 1922 as compared either with those of 1914 or the average from 1913 to 1922 are lower, and so is the return per acre. This is due both to lower yields and lower values per unit of yield. It was thought during the early years of the project that average acre production would be materially increased by cultivation and better farming methods, but the comparison of results as reported by the United States Reclamation Service shows that this is not the case. From observations of good farming practice on the project and results obtained at the experiment farm, it is believed that with better farming the average yields could be made nearly double those reported in these tables.

The figures given for crop values per acre in Tables 2, 3, and 4 call for a few words of explanation and comment. It is shown in Table 2 that the average value of all crops in 1922 was $10.28 per acre. This figure is given as the value of the crop produced on the irrigated land. The project includes 1,035 farms, averaging 55 acres of irrigated and cropped land per farm. It might be inferred from these figures that the average income per farm in 1922 was $565.40. Such an inference would not be justified by the facts.

The figures showing the average farm value per acre are obtained by dividing the total farm value by the number of acres cropped. The total farm value is obtained by multiplying the total yield by a certain value per unit of yield. This value per unit of yield is presumably based upon prices quoted toward the close of the year, as of December 1. In so far as it applies to such commodities as wheat, alfalfa seed, sugar beets, or potatoes, which are usually sold off the farm, this method of computation gives a fair measure of the crop returns. For such crops as alfalfa, hay, and corn, which are largely fed on the farm,

it may be very misleading. In the case of the alfalfa crop on the Belle Fourche project, it is probable that only a very small proportion was sold at $5 per ton, the price given. A substantial part of the crop was fed on the farms where produced. Where alfalfa hay is fed on the farm it should be allowed a value of at least $10 per ton, or else a liberal allowance should be made for profit on feeding it to farm animals. It is estimated, for example, that when butterfat is worth 30 cents per pound alfalfa hay is worth $15 per ton as feed for dairy cows. If the hay fed to cows on the farm is charged at $5 per ton, then allowance must be made for a good profit on the feeding operations. The same thing holds for corn. Very little of this crop is sold direct from farms on the Belle Fourche project. It is fed to hogs and sheep. It has been shown by careful tests that a hog having access to alfalfa pasture and fed 2 pounds of corn daily for each 100 pounds of weight will make a pound of gain for each 2.7 to 3 pounds of grain consumed. This is equivalent to 20 pounds of gain for each bushel of corn. In estimating the farm value of corn the local price of hogs is a better criterion than the local quotations for occasional lots of corn that may be for sale.

Owing to the rolling nature of the lands a large acreage of nonirrigable land is included within the project, and many farms on the project have from a few to 160 acres of such land. To date, most of this land has been used for pasture purposes only, but from results obtained by cultivation it is believed that much of this dry land might be more profitably used for crop production. This subject is considered later in this report.

LIVESTOCK

Table 5 shows the livestock on hand on January 1 and December 31, 1922, their value, and the increased total value. These figures were obtained from the printed reports of the United States Reclamation Service.

TABLE 5.—*Inventory of livestock on the Belle Fourche Reclamation Project in 1922*

[Each number marked with an asterisk (*) is only an approximation. The minus sign indicates decrease in value]

Item	Inventory, Jan. 1			Inventory, Dec. 31			Increased total value
	Number	Value	Total value	Number	Value	Total value	
Horses and mules	3,890	$51.00	$198,390	3,418	$42.27	$144,478*	−$53,912
Cattle:	5,390	38.00	204,820	4,907	38.91	190,951*	−13,886
Beef							
Dairy	3,870	46.00	178,020	3,778	42.95	162,265*	−15,755
Sheep	48,510	5.00	242,550	40,028	6.55	262,183*	19,633
Hogs	13,260	7.70	102,102	12,792	9.11	116,535*	14,433
Fowls	26,560	.55	14,608	33,171	.62	20,566*	5,958
Bees, hives	510	6.70	3,417	685	6.82	4,671*	1,254
Total			943,907			901,629	−42,278

Table 6 shows the inventory and average values, also the total value, of livestock at the close of each year from 1913 to 1922, inclusive, the figures being obtained from the printed reports of the United States Reclamation Service.

TABLE 6.—*Inventory and value of livestock on hand on the Belle Fourche Reclamation Project at the close of each year for the 10-year period, 1913–1922*

Livestock	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Number:										
Horses	2,490	2,848	3,135	3,514	3,734	3,877	4,238	3,608	[a] 3,890	[a] 3,418
Mules	89	59	65	86	88	97	80	100		
Cattle:										
Beef	[a] 2,758	2,514	5,524	8,178	6,616	4,801	8,806	3,751	5,390	4,907
Dairy		1,578	2,200	2,870	2,912	3,330	2,421	2,969	3,870	3,778
Sheep	12,872	25,740	26,210	32,152	36,459	35,607	75,398	34,781	48,510	40,028
Hogs	4,636	11,988	14,798	13,631	10,946	9,007	19,837	11,037	13,260	12,792
Fowls	23,125	29,186	21,315	27,094	24,028	18,975	20,699	20,584	26,560	33,171
Bees, hives	139	129	326	541	541	852	900	243	510	685
Average value per head:										
Horses	$90.32	$87.50	$92.80	$88.83	$91.18	$77.53	$59.04	$68.30	[a] $51.00	[a] $42.27
Mules	83.65	112.45	120.00	104.30	108.24	83.76	64.10	53.45		
Cattle:										
Beef	[a] 46.14	46.50	47.51	42.58	50.53	63.18	49.25	46.30	38.00	38.91
Dairy		57.75	56.00	56.92	60.65	66.69	79.00	58.29	46.00	42.95
Sheep	3.76	3.76	4.48	5.65	12.65	11.00	9.27	6.48	5.00	6.55
Hogs	8.75	8.97	6.75	8.48	15.10	15.12	17.18	8.86	7.70	9.11
Fowls	.46	.49	.59	.47	.73	.63	.64	.68	.55	.62
Bees, hives	5.76	6.20	7.45	5.34	5.34	7.33	9.50	8.63	6.70	6.82
Total value:										
Horses	224,897	249,200	290,928	312,149	340,466	300,584	250,212	246,426	[a] 198,390	[a] 144,479
Mules	7,445	6,635	7,800	8,970	9,525	8,125	5,128	5,345		
Cattle:										
Beef	[a] 127,254	116,901	262,445	348,219	334,306	303,327	433,696	173,671	204,820	190,931
Dairy		91,130	123,200	163,360	176,613	222,078	191,259	173,063	178,020	162,265
Sheep	48,399	96,782	117,421	181,659	461,206	391,677	698,939	225,381	242,550	262,183
Hogs	40,565	107,532	99,887	115,591	165,285	136,186	340,800	97,788	102,102	116,535
Fowls	10,638	14,301	12,576	12,734	17,540	11,954	13,247	13,997	14,608	20,566
Bees, hives	801	800	2,429	2,889	2,889	6,245	8,550	2,097	3,417	4,672
Total	459,999	683,281	916,686	1,145,571	1,507,830	1,380,176	1,941,831	937,765	943,907	901,631

[a] Not segregated.

Table 7 shows the number of carloads of livestock shipped from the four project towns during the years 1916 to 1922, inclusive, according to figures obtained from the district freight office at Deadwood, S. Dak.

TABLE 7.—*Carload lots of livestock shipped from four shipping points on the Belle Fourche Reclamation Project, 1916 to 1922, inclusive*

Year	Newell				Belle Fourche				Nisland				Fruitdale				Total			
	Cattle	Sheep	Hogs	Horses	Cattle	Sheep	Hogs	Horses	Cattle	Sheep	Hogs	Horses	Cattle	Sheep	Hogs	Horses	Cattle	Sheep	Hogs	Horses
1916	162	118	81	11	406	231	50	84	28	12	43	2	28	10	19	2	624	371	193	99
1917	233	131	77	5	760	216	35	98	92	39	29	1	72	35	13	7	1,157	421	154	111
1918	202	56	48	11	641	174	15	94	51	19	17	24	27	24	3	0	921	273	83	129
1919	208	87	79	89	1,364	318	36	281	28	22	30	1	17	24	3	0	1,617	451	148	371
1920	190	91	79	37	340	164	25	37	25	32	13	1	22	33	7	1	577	320	124	76
1921	72	135	92	3	354	263	28	14	18	42	24	1	16	19	2	0	460	459	146	18
1922	134	180	77	9	378	188	13	9	57	33	14	2	27	11	7	1	596	412	111	21

The principal livestock industries, taken as a whole, show a steady increase except for 1918 up to and including 1919. The increasing total value is partly due to increased numbers, but more to increased valuation. The livestock report for 1920 shows a decrease of more than 50 per cent as compared with the 1919 inventory. This decrease was due in part to the extremely hard winter of 1919–20. All livestock loans were called in that possibly could be, and much of the stock shipped was not yet ready for market. The livestock situation in 1922 shows some improvement in numbers over 1920, with the exception of horses and mules. The dairy cattle show an increase of more than 800 head during this period. The livestock industry on the project

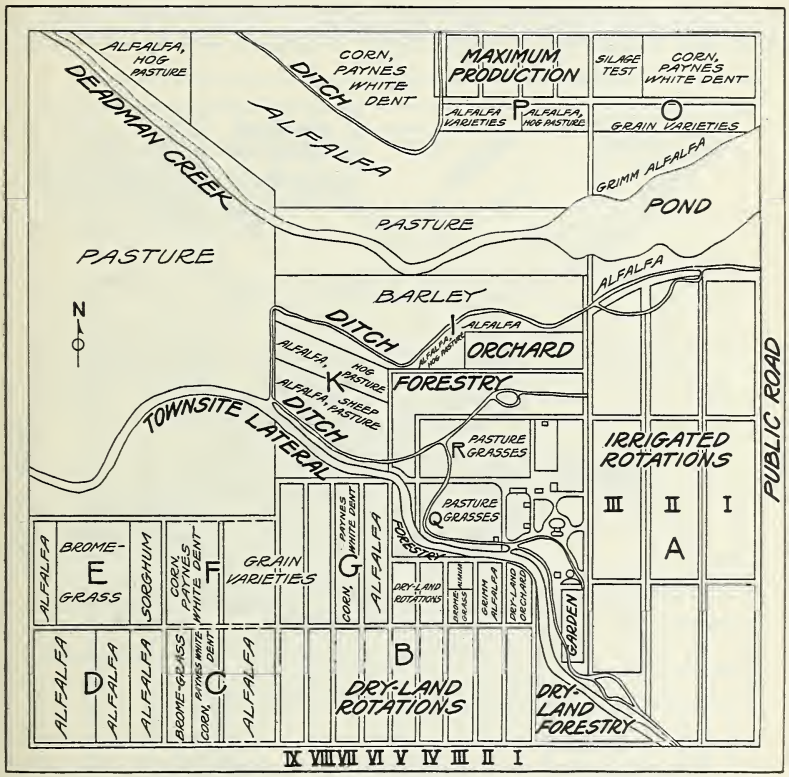

FIG. 1.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1919

should be increased enough to utilize all crops that are grown. Owing to the distance from the principal markets and the high freight rates all bulky crops should be consumed on the farm. This would give as a rule a much higher return for the crops, as well as higher yields per acre from the application of manure and pasturing.

The largest volume of stock was shipped out in 1919 and the smallest in 1921. The number of carloads of sheep has remained fairly constant during the six years. The largest shipment was made in 1921, when 459 cars were sent from the four project towns. The largest shipment of hogs, 193 cars, was made in 1916 and the lowest in 1918, when only 83 cars were shipped.

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INSECT PESTS

During the early years of the project there was no trouble with insect pests. Grasshoppers appeared in 1919 and again in 1920, but no great harm resulted. By 1922 they had increased to such numbers that serious damage was done to grain and particularly alfalfa left for seed. In 1920 the armyworm appeared in local areas but was controlled by poisoned bait. In 1921 there seemed to be no outbreak of this pest.

SCOPE OF THE INVESTIGATIONS

The work of the farm is devoted mainly to experiments in the production and utilization of crops under irrigation and by dry-farming

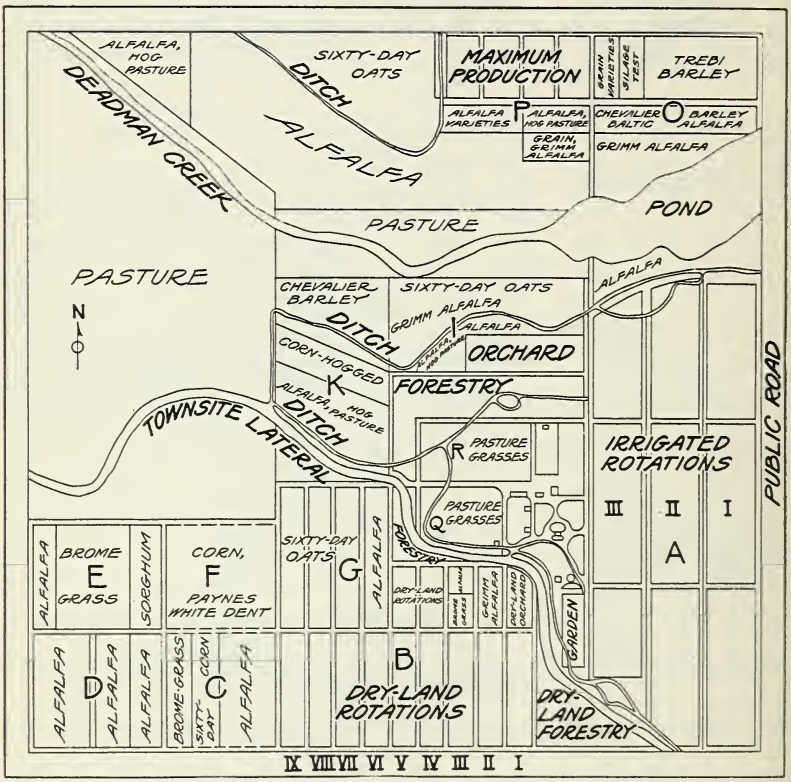

FIG. 2.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1920

methods on the Belle Fourche Reclamation Project. It relates chiefly to crops of local importance and includes experiments in crop rotation and tillage, tests of grain and forage crops, experiments in hog and sheep production, tests of pasture grasses, of trees for windbreaks and ornamental plantings, of garden vegetables, and of orchard and small fruit. Figures 1, 2, 3, and 4 show the arrangement of the fields and the location of the experiments in 1919, 1920, 1921, and 1922, respectively.

The experiment farm is in charge of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry, and facilities are provided for special investigations carried on by other agencies of the Department of Agriculture. The Bureau of Animal Industry in 1917 inaugurated experiments relating to hog production. This includes the testing of various feeds and quantities of grains used as supplements to alfalfa pasture, the cost of carrying brood sows through the season, and the harvesting of corn with hogs in the field. The Office of Dry-Land Agriculture uses about 20 acres of land above the canal for rotation and tillage experiments.

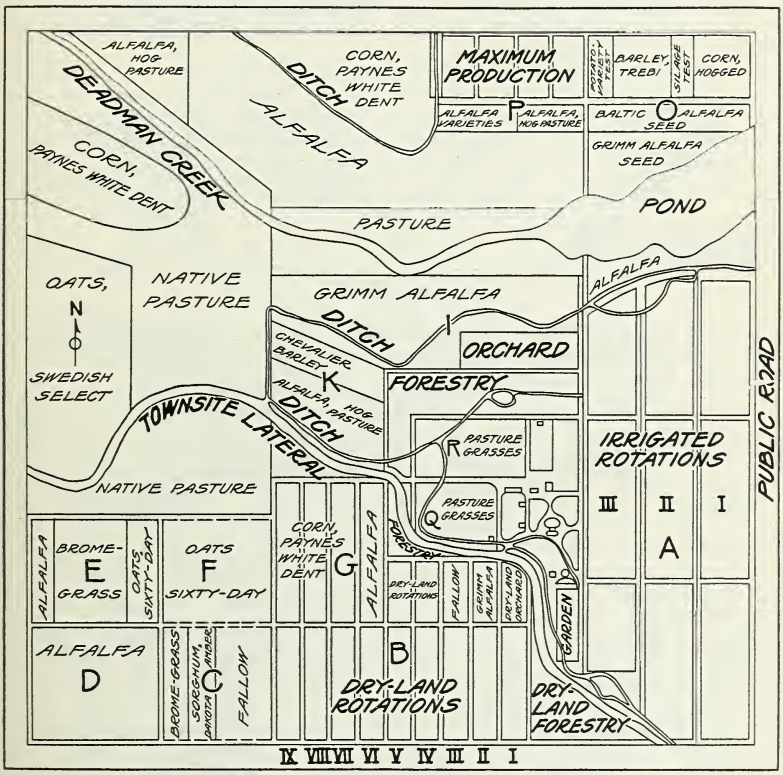

FIG. 3.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1921

The Biophysical Laboratory cooperates in all climatological and physical observations. This work includes measurements of rainfall, wind velocity, evaporation, temperature, and soil moisture. The testing of trees for wood-lot and windbreak purposes is carried on in cooperation with the Forest Service.

The results from certain of these investigations are summarized in the following pages, and progress is reported on the experiments in the production and utilization of irrigated crops.

ROTATION EXPERIMENTS WITH IRRIGATED FIELD CROPS

DESCRIPTION OF THE ROTATIONS[2]

The rotation experiments now occupy 129 plats of one-fourth acre each in field A. (Fig. 1.) They were begun in 1912. With the season of 1922 these experiments complete the eleventh year. It now becomes possible to see in the results obtained some facts which may be useful to those engaged in crop production under similar conditions.

CROP YIELDS

Table 8 shows the maximum, minimum, and average yields per acre in the irrigated rotations on the Belle Fourche Experiment

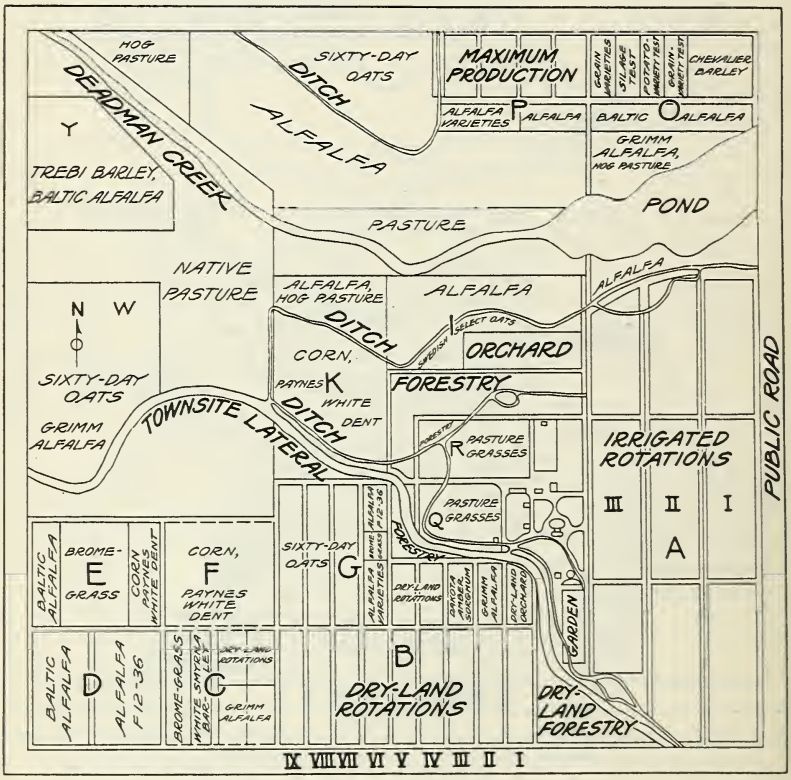

FIG. 4.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1922

Farm in 1922 and a comparison of the average yields in 10 previous years, showing a wide difference between the highest and the lowest yields obtained from the different plats. Each crop was planted at the same time on the various plats, with the exception of alfalfa. The same variety of seed was used on all plats, and the cultural treatment was the same for each crop in the rotation, so the

[2] For a detailed list of these experiments, see Aune, Beyer, The work of the Belle Fourche Reclamation Project Experiment Farm in 1917. U. S. Dept. Agr., Bur. Plant Indus., W. I. A. Cir. 24, 31 pp., illus. 1918.

difference in yield must be due to the differences in the plats. These differences in the plats may be due in part to the application of manure to the preceding crop and to soil variation. Before comparing crop yields these facts must be borne in mind.

TABLE 8.—*Yields of crops grown in the irrigated rotation experiments on the Belle Fourche Experiment Farm, 1912–1922*

[The yields of alfalfa hay, clover hay, and sugar beets are shown in tons; the yields of all the other crops are shown in bushels]

Crop	Number of plats, 1922	Yields per acre, 1922			Average yields per acre									
		Maximum	Minimum	Average	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921
Alfalfa hay	31	5.46	1.14	3.04	----	2.6	3.0	3.17	3.42	3.0	3.27	3.26	2.66	3.0
Sugar beets	22	20.8	4.3	13.3	7.6	7.8	11.6	9.20	7.1	12.35	10.24	-----	7.9	10.0
Corn	7	63.9	24.5	38.0	28.7	33.4	44.7	29.9	39.5	42.92	40.0	37.1	32.1	40.9
Wheat:														
Winter	3	15.0	------	8.8	----	11.3	22.9	27.2	11.9	16.9	21.7	10.7	4.0	11.0
Spring	7	30.9	12.0	19.0	22.1	19.9	25.7	20.9	10.0	27.8	25.0	15.8	9.8	10.9
Oats	26	71.1	23.4	51.2	51.9	39.0	78.8	92.1	54.7	59.2	73.0	41.9	27.3	41.9
Barley	2	32.5	10.0	21.3	28.0	14.8	31.7	51.2	24.4	27.0	21.8	14.4	17.7	14.8
Flax	4	17.6	8.9	12.7	13.6	13.4	14.8	15.1	7.07	14.6	17.7	7.3	8.0	11.9
Potatoes	18	244	80.7	158.2	45.5	112.5	105.9	116.8	153.8	148.7	164.3	60.7	-----	152.8
Clover:														
Hay	2	.52	.44	.48	----	-----	.44	1.18	.66	------	1.78	2.07	1.58	.7
Seed	2	.30	.10	.20	----	-----	------	1.77	2.08	------	1.00	.5	-----	.9

ALFALFA

The alfalfa yields in 1922 compare favorably with those for the past 10 years, considering that the grasshoppers damaged the crop to some extent. The maximum yield (5.46 tons per acre) was obtained on a continuously cropped plat that was established in 1912 and that commencing in 1916 was manured in the fall each year at the rate of 12 loads per acre of barnyard manure. The average for all plats including the first year of fall and spring seeded alfalfa was 3.04 tons per acre. The lowest yield was obtained on a fall-seeded plat that produced only 1.14 tons per acre; however, this plat was damaged by grasshoppers. The average yield for established alfalfa was 3.90 tons for the three cuttings. For the first time since the practice of fall seeding was begun the yield for the first year was lower than that of spring-seeded alfalfa without a nurse crop. If grasshoppers are numerous fall seeding is not practicable, because the alfalfa will be eaten before becoming established. During a grasshopper siege about the only way that a stand can be obtained is to sow the alfalfa alone early in the spring. This will give it a chance to get started before the insects are of sufficient size to cause much damage. Table 9 shows the comparative yields in 1922 of the alfalfa plats in the irrigated rotations, grouped as to age and time of seeding.

TABLE 9.—*Comparative yields of alfalfa on the experiment farm, 1922*

Time and method	Number of plats	Average yield per acre (tons)			Total for season
		First cutting	Second cutting	Third cutting	
First year, fall seeded	7	0.30	0.72	0.48	1.50
First year, spring seeded	5	----------	1.21	.59	1.80
Second year, fall seeded	7	1.42	1.66	.92	4.00
Second year, spring seeded	5	.92	1.64	1.03	3.59
Third year	4	1.22	1.78	.91	3.91
Tenth year	2	1.50	1.56	.84	3.90
Tenth year, manured	1	1.98	2.06	1.42	5.46

SUGAR BEETS

The yields of sugar beets in the irrigated rotations in 1922 were the most satisfactory to date, particularly where the beets followed a cultivated crop with manure and on corn ground pastured with sheep. Table 10 shows the yields of sugar beets from 1912 to 1922, inclusive, except 1919, and the sequence of crops preceding the beets.

TABLE 10.—*Yields of sugar beets, with the sequence of crops, in the irrigated rotation experiments, 1912–1922 except 1919*

[The application of manure wherever noted was made after the preceding crop mentioned was harvested]

Crop sequence	Rotation No.	Yields per acre (tons)										Average for period (except 1919)	
		1912	1913	1914	1915	1916	1917	1918	1920	1921	1922	10 years	Last 5 years
Potatoes, beets (manure)	21	6.9	8.8	14.6	16.0	12.1	18.6	13.2	11.2	17.5	18.8	13.77	15.86
Oats (manure), beets	23	5.7	8.3	10.6	11.8	9.6	20.9	11.6	11.6	16.5	17.4	12.40	15.60
Alfalfa 3 years, potatoes, oats (manure), beets	61	7.1	6.0	12.7	10.9	10.4	15.7	13.8	7.4	12.7	17.3	11.40	13.38
Oats (manure), potatoes, beets	35	----	----	----	----	----	17.4	14.5	11.5	15.0	19.9	------	15.66
Potatoes, beets	20	7.0	10.7	11.3	12.2	9.7	15.3	10.9	9.3	15.7	14.2	11.63	13.08
Potatoes, oats (manure), beets	31	8.4	9.3	14.2	13.2	8.2	15.3	12.2	7.3	9.2	17.3	11.46	12.26
Alfalfa 2 years, potatoes, beets	40	8.2	8.5	12.8	11.0	8.8	14.2	11.0	8.9	11.9	13.8	10.91	11.96
Oats, potatoes, beets	34	----	----	----	----	----	11.7	14.8	8.6	16.8	17.1	------	13.80
Alfalfa 3 years, potatoes, oats, beets	60	8.4	8.0	11.2	9.4	7.2	12.7	13.7	8.4	8.9	13.5	10.14	11.44
Oats, beets	22	7.6	7.6	12.3	9.1	8.1	12.7	8.6	9.1	11.9	13.3	10.03	11.12
Alfalfa 3 years, potatoes, beets, oats	64	----	----	----	----	----	12.2	12.3	8.2	11.4	15.9	------	12.00
Alfalfa 3 years (3d year sheeped), corn (sheeped), oats, beets	71	----	----	----	----	5.8	15.8	14.3	6.9	11.2	20.8	------	13.80
Alfalfa 2 years, oats, beets	42	9.5	8.7	11.1	7.0	4.2	10.2	8.9	6.8	8.5	12.2	8.71	9.32
Continuously cropped beets	2a	----	----	6.9	4.6	6.8	9.1	6.7	9.6	6.6	10.1	------	8.42
Wheat, beets	18	7.3	7.8	9.3	8.8	5.8	11.7	8.0	5.6	7.5	8.7	8.05	8.30
Alfalfa 3 years, corn, oats, beets	62	7.5	7.0	10.7	8.3	4.9	8.5	9.9	7.2	5.6	10.1	7.97	8.26
Potatoes, oats, beets	30	7.4	9.0	10.7	7.3	4.6	7.4	7.3	5.0	8.4	11.2	7.83	7.86
Corn, oats, beets	32	8.6	6.5	8.7	6.8	4.0	7.6	6.0	4.6	6.2	9.7	6.87	6.82
Potatoes, oats, beets	30a	----	----	----	----	----	6.6	7.8	7.2	5.5	12.7	------	7.96
Continuously cropped beets	2	4.1	4.7	6.7	4.6	5.8	8.2	5.8	7.5	4.9	6.3	5.86	6.54
Oats, alfalfa 2 years, beets	46	----	----	----	----	----	12.8	6.6	6.3	4.5	7.2	------	7.48
Flax, barley, corn, winter wheat, clover, beets	66	10.4	5.5	10.5	5.1	6.9	6.5	7.2	6.2	3.7	4.2	6.62	5.56
Maximum	------	10.4	10.7	14.6	16.0	12.1	20.9	14.8	11.6	17.5	20.8	14.94	17.12
Minimum	------	4.1	4.7	6.7	4.6	4.0	6.5	5.8	4.6	3.7	4.2	4.89	4.96
Average	------	7.6	7.8	10.9	9.1	7.2	12.3	10.2	7.9	10.0	13.3	9.63	10.74

The maximum yield for 1922 was obtained in rotation No. 71, where beets followed corn pastured with sheep. This plat yielded 20.8 tons per acre. The average yield for the 22 plats on which beets were grown was 13.3 tons per acre and the minimum 4.2 tons per acre in rotation No. 66, where beets followed red clover. On this plat there was only about a 50 per cent stand, and yet the average size of the beets was the smallest of any of the plats in the experiment, weighing only 12.9 ounces. The maximum average weight was 28.6 ounces in rotation No. 21, and the average for all the rotations was 20.1 ounces per beet. The increase in yields on the manured rotations was very marked in 1922. In rotation No. 20 (the sequence being potatoes, beets) and in rotation No. 21 (the sequence being potatoes, beets, followed by manure) the difference in favor of the manured rotation was 4.6 tons per acre. In two similar rotations, No. 30 (the sequence being oats, beets, potatoes) and No. 31 (the sequence being oats followed by manure, beets, potatoes), the difference in favor of rotation No. 31, which was manured, was 6.1 tons

per acre. The average yield in eight rotations without manure was 13.49 tons per acre, while in five rotations where 12 tons of manure are applied once during the rotation the average yield was 18.4 tons per acre, a difference of 4.91 tons per acre in favor of the manured plats.

Previous to harvesting the beets, samples from each plat were sent to the sugar factory at Scottsbluff, Nebr., for sugar analysis. The maximum, coming from rotation No. 2a, a continuously cropped plat since 1912, was 18.6 per cent. The minimum, 13.4 per cent, was from rotation No. 66, beets following red clover. The average of all the rotations was 16.2 per cent. The average percentage of sugar is not quite as high as in previous years, but this is more than made up by the increased yields. The average sugar percentages for the years 1912 to 1922, inclusive, were as follows:

	Per cent		Per cent		Per cent
1912	14.8	1916	19.1	1920	19.1
1913	19.1	1917	20.2	1921	17.9
1914	22.1	1918	19.9	1922	16.2
1915	17.7	1919	no crop		

CORN

The crop season for 1922 was one of the most favorable for corn production since the project was started. Table 11 shows the crop sequence, the measured yields of corn from 1912 to 1922 in seven rotations, and the estimated yields of corn in two rotations.

TABLE 11.—*Yields of corn, with the sequence of crops, in the irrigated rotation experiments, 1912–1922*

Crop sequence	Rotation No.	Yields per acre (bushels)												
		1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Average for period	Last 5 years
ACTUAL YIELD														
Continuously cropped corn	6a	----	----	51.1	32.1	42.6	48.0	48.0	44.5	35.3	49.9	34.1	42.8	42.4
Winter wheat, clover, beets, flax, barley, corn	66	24.0	43.0	39.4	43.2	46.9	53.8	31.8	27.7	39.0	40.3	63.9	41.2	40.5
Potatoes, corn	26	24.0	21.6	44.4	31.6	44.3	44.1	46.5	44.7	31.0	53.1	29.9	37.7	41.0
Oats, beets, corn	32	30.0	30.5	32.5	28.5	40.5	49.6	47.0	42.3	38.4	36.3	33.1	37.2	39.4
Oats, beets, alfalfa 3 years, corn	62	28.5	32.3	44.4	32.2	42.8	42.6	40.0	38.4	29.0	34.1	40.5	36.8	36.4
Oats, corn	16	37.0	33.1	48.8	28.8	37.5	39.7	38.3	29.3	28.1	38.4	40.0	36.3	34.8
Continuously cropped corn	6	----	39.4	52.1	12.8	21.9	22.7	28.5	32.5	23.9	33.9	24.5	29.2	28.7
Maximum	------	37.0	43.0	52.1	43.2	46.9	53.8	48.0	44.7	39.0	53.1	63.9	47.7	49.7
Minimum	------	24.0	21.6	32.5	12.8	21.9	22.7	28.5	27.7	23.9	33.9	24.5	24.9	27.7
Average	------	28.7	33.3	44.7	29.9	39.5	42.9	40.0	37.1	32.1	40.9	38.0	37.0	37.6
ESTIMATED YIELD														
Flax, oats, alfalfa 3 years (third year hogged), corn (hogged)	65	28.7	34.0	34.8	40.6	59.1	67.4	55.8	40.9	42.8	63.7	68.1	48.7	54.3
Oats, alfalfa 3 years (third year hogged), corn 2 years (hogged)	69	----	----	----	34.1	47.7	55.4	56.7	39.9	43.6	53.7	68.9	50.0	52.6
Maximum	------	28.7	34.0	34.8	40.6	59.1	67.4	56.7	40.9	43.6	63.7	68.9	48.9	54.8
Minimum	------	----	----	----	34.1	47.7	55.4	55.8	39.9	42.8	53.7	68.1	49.7	52.1
Average	------	----	----	----	37.4	53.4	61.4	56.3	40.4	43.2	58.7	68.5	52.4	53.4

Of the corn plats that were harvested in 1922, the highest yield, 63.9 bushels per acre, was obtained in rotation No. 66. The lowest yield was on a plat continuously cropped since 1912, producing only

24.5 bushels per acre. The average yield for all harvested corn plats was 38 bushels per acre.[3]

In rotations Nos. 65 and 69 the corn is harvested with hogs, and rotation No. 71 is harvested with lambs. The estimated yields per acre for these rotations for 1922 are: Rotation No. 65, 68.1 bushels; rotation No. 69, 68.9 bushels; and rotation No. 71, 60 bushels. In examining Table 11 it will be noted that in the rotations which include neither manure nor pasturing the yields of corn are practically the same as when the rotations were first started in 1912. In rotations where the alfalfa and corn have been pastured with hogs or sheep the yields have increased materially, particularly in 1921 and 1922. Corn when properly handled seems to be well adapted as a grain crop under irrigation on the Belle Fourche project. The best variety tested to date is Payne White Dent.

OATS

Table 12 shows the crop sequence and the yields of oats from 1912 to 1922, inclusive.

TABLE 12.—*Yields of oats, with the sequence of crops, in the irrigated rotation experiments, 1912–1922*

[The application of manure wherever noted was made after the preceding crop mentioned was harvested]

Crop sequence	Rotation No.	Yields per acre (bushels)											Average for period	
		1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	11 years	Last 5 years
Potatoes, oats (manure)	25	41.1	33.8	52.7	104.0	54.6	74.4	90.6	58.9	49.5	60.0	71.1	62.8	66.0
Potatoes, oats	24	47.6	44.0	73.6	112.0	58.0	72.9	89.6	60.3	49.2	56.8	53.6	65.2	61.9
Potatoes, oats (rye plowed under)	27	43.3	39.1	77.7	101.3	62.6	75.4	92.1	55.5	41.4	53.4	64.0	64.2	61.3
Beets, potatoes, oats (manure)	31	65.6	51.0	90.0	104.0	71.5	75.6	80.8	54.1	46.0	59.6	57.9	68.7	59.7
Beets, oats (manure)	23	55.3	44.4	74.8	103.5	43.8	76.0	91.9	50.0	34.4	47.3	66.1	62.5	57.9
Potatoes, beets, oats (manure)	35	----	----	----	----	----	----	82.9	44.9	39.2	43.8	64.8	----	55.1
Beets, oats	22	57.4	45.0	77.5	99.1	57.4	71.5	86.8	48.6	36.8	45.4	53.9	61.8	54.3
Potatoes, beets, oats	34	----	----	----	----	----	----	73.9	53.9	36.9	41.6	62.6	----	53.8
Alfalfa 3 years (third year hogged), corn 2 years (hogged), oats	69	----	----	----	81.4	57.4	60.1	89.8	38.8	29.1	56.5	53.6	----	53.6
Alfalfa 3 years (third year sheeped), corn (sheeped), beets, oats	71	----	----	----	----	42.0	60.0	92.6	54.8	23.7	30.6	64.1	----	53.2
Beets, potatoes, oats	30a	----	----	----	----	----	37.0	66.0	36.4	32.8	48.3	68.1	----	50.3
Do	30	40.7	46.8	93.5	106.9	56.0	65.9	70.4	37.0	37.0	60.8	44.3	59.9	49.9
Beets, potatoes, oats, alfalfa 3 years	60	50.0	35.0	94.6	108.9	49.8	51.8	77.8	30.1	27.8	54.5	53.0	57.6	48.6
Potatoes, beets, oats, alfalfa 3 years	64	----	----	----	----	----	----	71.2	34.9	34.3	33.3	69.4	----	48.6
Beets, potatoes, oats (manure), alfalfa 3 years	61	54.6	39.0	100.4	114.1	82.8	49.0	81.1	39.5	22.6	37.8	51.8	61.2	46.6
Alfalfa 2 years, wheat, oats	48	80.0	54.0	105.3	118.5	58.4	69.4	86.3	57.0	13.0	31.4	43.4	65.2	46.2
Alfalfa 3 years (third year hogged)	65	54.0	28.9	84.8	117.1	74.3	73.4	82.9	50.1	11.1	24.4	49.0	59.1	43.5
Corn (hogged), flax, oats	44	60.5	54.4	109.6	116.5	80.3	71.9	83.4	60.5	6.9	41.4	23.4	64.4	43.1
Oats, corn	16	55.3	44.8	74.5	65.3	49.2	42.3	57.8	35.6	28.6	45.0	31.6	48.2	39.7
Alfalfa 2 years, beets, oats	46	----	----	----	----	----	----	56.0	17.9	25.5	30.6	49.8	----	36.0
Corn, beets, oats	32	43.7	30.5	92.2	72.5	62.5	41.4	53.6	24.5	7.5	42.3	49.8	47.3	35.5
Corn, beets, oats, alfalfa 3 years	62	45.6	28.5	103.7	79.8	63.6	45.2	66.8	19.1	9.2	34.6	47.3	49.4	35.4
Continuously cropped oats	1a	----	----	103.3	82.5	41.6	57.3	55.6	57.4	12.5	26.8	23.8	----	35.2
Beets, alfalfa 2 years, oats	42	61.5	26.1	61.1	74.6	28.7	35.5	48.3	16.5	22.5	33.9	47.1	41.4	33.7
Wheat, oats	28	35.4	31.9	26.3	50.0	27.1	40.4	36.3	28.6	15.0	26.9	32.6	31.9	27.9
Continuously cropped oats	1	42.7	24.1	25.5	39.9	24.6	34.8	34.4	24.4	14.5	22.4	34.3	29.2	26.0
Maximum	----	80.0	54.4	109.6	118.5	82.8	76.0	92.6	60.5	49.5	60.8	71.1	77.8	66.9
Minimum	----	35.4	24.1	25.5	39.9	24.6	34.8	34.4	16.5	6.9	22.4	23.4	26.2	20.7
Average	----	51.9	39.0	80.1	92.6	54.6	58.2	73.0	41.9	27.2	41.9	51.2	55.6	47.0

[3] The method used to estimate the yield for corn on the plats that were hogged is as follows: The stand is determined by actual count on the quarter-acre plat. The ears are harvested from 100 plants. If there are 2,360 plants on the quarter-acre plat the ears would be harvested from every 23d plant. The total air-dry weight of the ears harvested from the 100 plants multiplied by 23.6 equals the total weight of corn on the plat, and this divided by 70 would give the number of bushels on the plat. In using this method on acre plats the stand would be determined by actual count and the ears harvested from 400 plants instead of 100 plants.

The maximum yield of oats in 1922 was obtained in rotation No. 25, the sequence being potatoes, then oats (manure), and the yield was 71.1 bushels per acre. The average yield for the 22 plats was 51.2 bushels, and the minimum yield came from rotation No. 44, the sequence here being two years of alfalfa, potatoes, and oats. This plat yielded only 23.4 bushels per acre. However, this rotation is located just across the road from a buckthorn hedge and was very badly affected with rust, much more so than any of the other plats in the field. Previous to planting the buckthorn hedge this was one of the highest yielding rotations for oats.

The yields of oats after a cultivated crop are the most satisfactory, and of these the best average is obtained in following beets. There is not a consistent increase in the yield of oats in the manured rotations. Wheat, barley, and flax require the same land preparation as has been recommended for oats and the same sequence in the rotation. Barley is a good grain crop to grow under irrigation, particularly for seeding to alfalfa, but it requires the best of land preparation and should always be grown after a cultivated crop. Small grains grown under irrigation are not a profitable crop and can not be recommended except when seeding to alfalfa.

POTATOES

Table 13 shows the sequence of crops in the rotations and the yields of potatoes at the Belle Fourche Experiment Farm for the years 1912 to 1922, inclusive, except 1920.

TABLE 13.—*Yield of potatoes, with the sequence of crops, in the irrigated rotation experiments, 1912–1922 except 1920*

[The application of manure wherever noted was made after the preceding crop mentioned was harvested]

Crop sequence	Rotation No.	Yields per acre (bushels)										Average for period (except 1920)	
		1912	1913	1914	1915	1916	1917	1918	1919	1921	1922	10 years	Last 4 years
Beets (manure), potatoes	21	59.3	133.3	117.2	192.0	169.7	190.0	215.7	68.7	243.3	244.0	163.3	192.9
Oats (manure), beets, potatoes	31	53.8	90.0	139.6	137.3	188.0	205.0	231.3	65.6	240.0	232.0	158.3	192.2
Beets, oats (manure), potatoes	35	----	----	----	----	----	----	162.7	82.0	242.0	210.7	----	174.4
Beets, alfalfa 2 years, potatoes	40	74.8	88.0	96.0	94.0	129.2	124.0	203.3	70.7	175.3	168.0	122.3	154.3
Oats (manure), potatoes	25	41.3	95.3	101.2	168.0	162.0	134.7	236.0	52.7	122.7	194.0	130.8	151.4
Beets, oats, potatoes	34	----	----	----	----	----	----	179.1	82.0	177.3	156.0	----	148.6
Oats, alfalfa 2 years, potatoes	44	56.0	176.6	127.2	144.0	149.0	170.0	152.7	78.7	175.3	167.3	139.7	143.5
Oats, beets, alfalfa 3 years, potatoes	60	88.7	97.3	105.2	105.3	118.7	108.0	170.0	82.3	145.3	164.7	118.6	140.6
Oats, beets, potatoes	30	49.9	74.3	68.0	58.7	166.0	139.0	168.2	96.0	118.0	163.3	110.1	136.4
Oats, potatoes	24	13.5	109.3	112.0	111.3	151.3	120.3	191.3	56.0	144.0	151.3	116.0	135.7
Corn, potatoes	26	34.4	120.6	116.0	112.0	149.0	161.3	187.0	72.7	166.7	120.7	124.0	136.8
Oats (manure), beets, alfalfa 3 years, potatoes	61	14.4	139.3	112.4	115.3	123.7	130.4	164.7	66.7	134.0	156.7	115.8	130.2
Oats, beets, potatoes	30a	----	----	----	----	----	----	133.3	44.3	86.7	179.3	----	110.9
Beets, potatoes	20	70.9	128.0	86.4	102.0	157.0	132.7	166.7	57.3	95.3	120.0	111.6	109.8
Continuously cropped potatoes	4a	----	----	131.2	143.3	175.0	192.7	168.0	36.3	105.3	121.3	----	107.7
Beets, oats, alfalfa 3 years, potatoes	64	----	----	----	----	----	----	144.7	13.3	171.3	130.0	----	101.3
Oats (rye plowed under), potatoes	27	25.8	114.6	94.4	66.7	154.3	127.9	24.3	33.3	171.3	80.7	89.3	77.4
Continuously cropped potatoes	4	7.8	96.0	102.0	86.0	152.7	146.5	59.0	33.3	90.3	86.7	86.0	67.3
Maximum	----	88.7	176.6	139.6	192.0	188.0	205.0	236.0	96.0	243.3	244.0	180.9	204.8
Minimum	----	7.8	74.3	68.0	58.7	118.7	108.0	24.3	13.3	86.7	80.7	64.1	51.3
Average	----	45.4	112.5	107.7	116.9	153.3	148.8	64.3	60.7	152.8	158.2	122.0	134.0

The maximum yield of 244 bushels per acre in 1922 was obtained in rotation No. 21, the sequence in this rotation being potatoes, beets (manure). Of these potatoes 93 per cent was marketable. The minimum yield came from rotation No. 27. This is a rotation of oats (rye plowed under) and potatoes. This plat yielded 80.7 bushels per acre, of which only 44 per cent was marketable. The average for all of the plats in 1922 was 158.2 bushels per acre, which is 36 bushels above the average for the last 10 years. There was a marked increase in the manured rotations over those not receiving any manure. The average yield of four rotations where manure is applied at the rate of 12 tons per acre once during the rotation preceding the potatoes was 220 bushels per acre, and of these 85 per cent was marketable. In four similar rotations where no manure was applied the average yield was 167 bushels per acre, and 81 per cent of these was marketable.

The yields of potatoes after alfalfa, while more satisfactory than in previous years, were not as good as after manure or even in rotations not receiving manure. In five rotations of potatoes following alfalfa the average yield was 157.3 bushels per acre, and of these about 80 per cent was marketable. The highest yield of potatoes following alfalfa was 168 bushels and the lowest yield 130 bushels per acre. From this experiment it appears undesirable to use the rotation of potatoes following alfalfa on the heavy gumbo soil.

The observations on crops in the irrigated rotation experiments in 1919, 1920, 1921, and 1922 are similar to those made in previous years, the most important of which are as follows: Alfalfa has shown no marked effect on the yield of crops that follow except where pastured by sheep or hogs. Grains following a cultivated crop have given better returns per acre than when following alfalfa or grain.

The application of manure has shown a marked increase in the yield of sugar beets and potatoes but not of grains. Sugar beets following potatoes or corn have given uniformly good results, and sugar beets following grain crops without manure and after clover have given uniformly poor results. Except when grasshoppers are present in large numbers, alfalfa seeded in the late summer after the grain has been removed has given satisfactory stands. When seeded at this time it has produced a higher yield the first year after planting and is a much more economical way of establishing a stand of alfalfa than planting in the spring without a nurse crop.

SILAGE CROPS

Tests of silage crops have been conducted since the season of 1917. The yields are shown in Table 14. The land in 1917 and 1918 was manured at the rate of 12 loads per acre and fall plowed. In 1920, 1921, and 1922 the silage crops were grown on land that had produced a grain crop the year before. The land each year was plowed in the fall. The corn was well dented each year when harvested, except the Red Cob. This variety has made the largest average yield, but being immature at the time of harvest produced silage that was sloppy and too sour and consequently of low feeding value. The sorgo produced very nearly as much tonnage per acre as the earlier ripening corn, but when stock had access to good alfalfa hay in a self-feeding rack they refused to eat the sorgo silage. In 1917 Red Amber sorgo was used; in 1920, kaoliang; and in 1921 and 1922, Dakota Amber.

TABLE 14.—*Yields of crops used for silage, 1917–1922*

Crop	Yields per acre (tons)						
	1917	1918	1919	1920	1921	1922	Average
Corn:							
Sweet Fodder	8.67	8.57	--------	8.14	8.54	8.38	8.46
Payne White Dent	10.37	8.17	--------	11.03	7.93	7.49	9.00
Red Cob	11.98	14.33	--------	10.91	9.40	11.48	11.62
Minnesota No. 13	--------	--------	--------	10.05	7.92	9.12	9.03
Dakota Amber sorgo	--------	11.27	--------	6.11	6.54	9.06	8.25
Mammoth Russian sunflower	12.59	12.84	--------	16.09	11.51	8.67	12.34

Of the three varieties of sorgo, the Dakota Amber produced the best silage, but even this was not eaten as readily as good corn silage. The Mammoth Russian sunflower has given the maximum yield of the crops tested for silage. The stock did not eat the sunflower silage as readily as that of corn and even with the larger yield than corn it is doubtful whether it produces any more actual feed value per acre than corn.

On the Belle Fourche project silage corn should be planted as early as corn used for the grain, usually May 5 to 15, depending on the season. This will allow the crop to mature and be ready for the silo before the first fall frost. Silage crops should be judged by their feeding value rather than by bulk or weight alone. For this reason corn varieties that have been known to mature in the locality should be used, rather than the so-called silage corn grown farther south.

ALFALFA-SEED PRODUCTION

In 1917 eight quarter-acre plats of established alfalfa were set aside for a seed-production test. On four of these plats the first crop was left for seed, and on the other four the first crop was cut for hay and the second was left for seed. Table 15 shows the results obtained during the years 1917 to 1921, inclusive. No seed crop was obtained in the last two seasons. The average yields indicate that the best results are obtained by using the first crop for seed production.

TABLE 15.—*Yields of alfalfa seed from plats on which the first crop was left for seed, compared with plats on which the first crop was cut for hay and the second crop left for seed, 1917–1921*

Crop	Yields of clean seed per acre (bushels)					
	1917	1918	1919	1920	1921	Average
First crop for seed	4.61	1.41	6.50	0	0	2.50
First crop for hay; second crop for seed	3.07	.13	0	0	0	.64

In 1922 four different plats were used for a seed-production test. On three of these the first crop was cut on June 1, 16, and 26, respectively, and on the fourth plat the first crop was left for seed. Table 16 shows the results obtained.

TABLE 16.—*Yields of hay and seed of Baltic alfalfa from three plats on which the first crop of hay was cut and of seed from a plat on which the first crop was left for seed in 1922*

Plat and date of cutting	Area of field	Yield per field		Yield per acre	
		First cutting	Seed	First cutting	Seed
	Acres	*Pounds*	*Pounds*	*Tons*	*Bushels*
Plat 1, cut June 1	0.47	1,380	22	1.47	0.78
Plat 2, cut June 16	.97	3,010	42	1.55	.72
Plat 3, cut June 26	1.12	4,520	59	2.02	.88
Plat 4, left for seed	.91	----------	59	----------	1.08

Practically all the seed on the plat cut June 1 and the plat left for seed was produced on second growth. The seed from the plat cut June 1 was not well matured and was of much poorer quality than that on the other plats. There were frequent rains all through July, and the grasshoppers and crickets caused serious injury, which accounts for the poor yield of alfalfa seed for the past three years.

Alfalfa-seed production is very uncertain, but these tests, covering a period of six years, indicate that under irrigation the best yields are obtained from the first crop. No specific recommendation can be made at this time as to the best way of handling a seed crop except that it is desirable to bring the alfalfa into bloom without too much vegetative growth, and this can be done by delaying irrigation, provided the season is dry. After the alfalfa is in full bloom it must be kept well irrigated. In 1919, when the best yields were obtained, the alfalfa was irrigated four times.

VARIETY TEST OF ALFALFA UNDER IRRIGATION FOR HAY[4]

Certain varieties of alfalfa, such as Grimm and Baltic, have been found more hardy in regions of severe cold and a dry climate than common alfalfa from milder climates. It was desired to test a number of varieties and strains of alfalfa under irrigation to determine which variety would produce the greatest yields of hay under conditions of abundant moisture supply. It was thought, too, that a difference in hardiness and vigor of growth might also be observed.

A test of eight varieties and strains of alfalfa, covering a period of three years, has been completed. The test included the following varieties: Grimm, Baltic, Canadian Variegated, Common (Kansas seed), Common (Martins, a strain grown in the eastern Black Hills since 1886), Common (Vale, another local strain), Cossack, and A. D. I. No. 12 (selected from the Turkestan variety).

The seed was planted May 13, 1915, in a series of 24 plats one-twentieth acre in area, each variety being planted in three replications. All varieties were seeded at the rate of 4½ pounds of seed per acre in drills 7 inches apart. A good stand was obtained in all plats. In April, 1916, a count was made of three square-yard areas on each

[4] Observations on this test were made by A. C. Dillman, of the Office of Alkali and Drought Resistant Plant Investigations, Bureau of Plant Industry.

plat and the number of plants per acre computed. Table 17 shows the average number of plants per acre for each variety.

Although there was a considerable difference in the number of plants per acre in several varieties, an inspection of the plats at different times during the growing season has shown a vigorous and even growth of all varieties and a sufficient stand of plants on all plats. No obvious winterkilling has occurred in any of the varieties, but the three common varieties seemed a little later in getting started in the spring, and the yield of the first cutting was slightly lower than that of the other varieties. No material difference in yield was shown in the second and third cuttings. Three crops of hay were harvested each season. Table 17 shows the average yield of three replications for the three cuttings in 1916, 1917, and 1918.

TABLE 17.—*Variety test of alfalfa under irrigation in 1916, 1917, and 1918*

Variety	Plants per acre in 1916	Yields of hay per acre (tons)			
		1916	1917	1918	Average
Common (Martins)	570,000	3.1	4.07	3.84	3.67
Common (Kansas seed)	530,000	3.27	4.10	3.80	3.72
Common (Vale)	480,000	3.17	3.61	3.62	3.47
Canadian Variegated	420,000	3.55	4.08	3.86	3.83
Baltic	400,000	3.47	4.28	3.88	3.88
Grimm	400,000	3.31	4.31	3.75	3.79
Turkestan (F–12, A. D. I.)	370,000	3.52	4.12	3.71	3.78
Cossack	340,000	3.32	4.02	3.75	3.70

There was no material difference under irrigation in the yields of the eight varieties and strains of alfalfa tested. The Baltic variety showed a slight superiority in yield of hay, its yield being above the average of all varieties tested in every crop except the third cutting in 1917. Table 18 shows the seed yields of varieties of alfalfa under irrigation in 1919.

TABLE 18.—*Seed yields of varieties of alfalfa under irrigation in 1919*

Variety	Yields of seed per acre (pounds)
Common (Martins)[1]	230
Common (Kansas seed)	183
Common (Vale)	193
Canadian Variegated[2]	142
Baltic (A. D. I. No. H4–60)[2]	142
Cossack	107
Turkestan (A. D. I. No. F–12)	193
Grimm (A D. I. No. 62)	203

[1] This variety (Martins) was probably favored slightly by being a border plat.
[2] The Canadian Variegated and Baltic varieties were accidentally mixed in threshing. The yield of the combined plats was at the rate of 142 pounds per acre.

Local strains of Black Hills alfalfa seem well adapted to conditions on the Belle Fourche project, and the yield of hay in tons per acre is about equal to any of the varieties tested. Owing to the fact that the seed is in greater demand and brings a higher price, Baltic, Grimm, and Cossack are preferred for seed production.

TREE PLANTING

Tests of various kinds of trees for shade and windbreaks have been carried on in cooperation with the Forest Service. In 1909 the following varieties were planted: Caragana, Russian white oleaster, Scotch pine, cottonwood, white elm, green ash, honeylocust, black locust, redcedar, white willow, golden willow, and Black Hills spruce. Hackberry and Austrian pine were added in the spring of 1910.

LAND PREPARATION

The land was broken in June, 1908, from native sod and was backset in the fall. The spring and summer of 1909 were very favorable to plant growth, and good stands were obtained with all varieties. They came through the winter of 1909–10 without serious injury, except the black locust and the Scotch pine. The black locust killed back rather badly, and most of the Scotch pine was killed out. The

FIG. 5.—Chinese elm on the Belle Fourche Experiment Farm, planted in 1912. Photographed in 1915

Austrian pine planted in 1910 was a total failure, and only about half a stand of hackberry was obtained from plantings made that year.

The season of 1910 was extremely dry, but all trees except the willows, which started growth in the spring, made a good growth during the season. The summer of 1911 was the driest on record, the rainfall for the year being only 6.64 inches. The trees made very little growth during the summer, but none of the varieties were killed by the drought. They all passed successfully through the winter of 1911–12 and made a good growth during the summer of 1912. (Fig. 5.) There was an abundance of rain in the latter part of that summer and early fall, so the season's growth did not ripen up well to go into the winter. During the winter of 1912–13 the cottonwoods, black locusts, and white and golden willows were killed to the ground. This was probably due more to winter drying than to the frosts, as these species, except the black locust, came through successfully where

irrigated. The green ash for the first six years had the appearance of the most promising tree for dry-land conditions, but in 1917 the trees were badly infested with borers, and practically all died during the summer of 1918. Table 19 shows the varieties of trees that have survived to date, their growth in 1921, and their total height.

TABLE 19.—*Results of experimental tree plantings on the dry land in 1921*

Species	Date planted	Growth in 1921	Total height	Species	Date planted	Growth in 1921	Total height
		Inches	*Feet*			*Inches*	*Feet*
Siberian pea-tree	1909	8	8	Redcedar	1909	14	9
Russian white oleaster	1909	8	15	Black Hills spruce	1909	8	4.5
White elm	1909	18	12	Honeylocust	1909	17	15
Hackberry	1910	14	8				

FIG. 6.—Trees planted for a windbreak on the Belle Fourche Experiment Farm. Photographed July 29, 1912

The results of observations covering a period of 13 years with dry-land tree plantings are as follows:

(1) The land where the trees are to be planted must be thoroughly subdued previous to planting. This can be done by using a cultivated crop, but preferably by summer fallowing.

(2) Of the surviving species reported in Table 19, the most desirable seem to be Russian white oleaster, white elm, redcedar, Siberian pea-tree, honeylocust, and hackberry.

(3) A much wider spacing is necessary than was at first recommended. The rows should be at least 24 feet apart, the trees set 6 feet apart in a row, and clean cultivation practiced. As the trees develop it may be necessary to do some thinning.

(4) Trees 1 or 2 years old are preferable to larger sizes, as they are cheaper and much more easily established than older trees.

IRRIGATED LAND

About 7 acres are used for testing trees under irrigation for windbreak purposes. Plantings were begun in 1912. (Fig. 6.) Table 20 shows the species of trees, date of planting, growth in 1921, and the total height.

The land must be thoroughly subdued before planting the trees, to kill out all the native grasses. This can be done by growing cultivated crops or by summer fallowing previous to planting the trees. To insure plenty of moisture for the spring planting the land should be irrigated in the fall. Stock not more than 2 years old should be used. The planting can be done by first marking the land into rows 8 feet apart, the trees 4 to 6 feet apart in the row being a satisfactory distance under irrigation. The rows may be marked out with a plow or lister, the trees set out at the intersections, and the furrow filled back with a

FIG. 7.—Irrigated forestry as seen from the south, Belle Fourche Experiment Farm, October, 1920

2-horse cultivator. The trees should be kept free from weeds by frequent cultivations and should be irrigated frequently during the summer. It is well to keep the water off during the latter part of the growing season, so as to allow the wood to ripen for the winter. A late fall irrigation is desirable, as the trees will go through the winter in much better shape and are less liable to winterkill when wet than when dry. During the first four or five years after planting, the trees must be kept free from weeds by cultivation. After the trees become of good size a mulch of straw helps to hold the soil from washing, particularly if the windbreak is located on sloping ground.

All varieties listed in Table 20 have done well to date and seem to be hardy for the locality. The green ash for the first four or five years showed promise of being one of the best and most hardy trees, but of late years it has been badly infested with borers, so that this variety can not be recommended. (Fig. 7.)

TABLE 20.—*Results of experimental tree plantings on the irrigated land in 1921*

Species	Date planted	Growth in 1921	Total height	Species	Date planted	Growth in 1921	Total height
		Inches	*Feet*			*Inches*	*Feet*
Russian white oleaster	1913	20	14	Chinese elm (S. P. I. No. 22975)	1912	40	23
Caragana	1913	8	8	White willow	1912	30	18
White elm	1912	30	13	Jack pine	1914	20	10
Honeylocust	1914	30	15	Bull pine	1914	9	4.5
Cottonwood	1914	30	17	White cedar	1916	8	2.5
Green ash	1912	15	12	Black Hills spruce	1916	10	2.5
Boxelder	1914	20	15				
Golden willow	1914	40	23				

From observations to date the Russian white oleaster, white elm, honeylocust, native cottonwood, jack pine, bull pine, and caragana seem to be the most desirable for windbreak purposes under irrigation in western South Dakota. The white and golden willows make excellent windbreaks and grow rapidly when planted where they have access to water, particularly near a ditch or a low place where the water is backed up to them. The Chinese elm (S. P. I. No. 22975) has shown special promise, but so far this variety has not been widely distributed and would be limited more to ornamental plantings than for windbreak purposes.

THE FARMSTEAD

Every farm should have a well arranged farmstead. The farmstead includes the farm buildings and yards, garden, orchard, windbreak, and smaller pastures for stock. No farmstead plan can be made that is suitable for all farms, but some general principles may be stated. The size of the farmstead on an 80-acre farm would probably have to be limited to 5 or 6 acres, but on a larger farm this could well be increased to 10 acres. No time, money, and energy can be spent to better advantage than in developing a farmstead, not only as a desirable place to live but on account of the influence it has on the farm business and the increase in the value of the farm as a whole. Should the time come when the farm is to be sold, it will command a much higher price per acre than a farm not so improved. The first thing to consider is the location of the farmstead. Whenever possible the farmstead should be located near the public highway, and at the same time the fields must be so arranged as to make them readily accessible from the farmstead.

The windbreak should be placed on the north and west sides. The living house should be next to the road, with lawn and ornamental plantings, and should be separated from the barns and yards by plantings. The barns and yards should not be too close to the living quarters, 150 to 200 feet being a good distance. The barns and yards should always have a southern exposure where possible and be connected up to the north and west with high board fences, this giving excellent protection for the stock during cold weather. The arrangement of the lawn and ornamental plantings can be very simple and yet attractive. The plantings should be placed in groups, leaving the lawn open, which permits it to be taken care of much more easily.

In 1914 the following ornamental shrubs were set out on the station grounds and all varieties to date have proved hardy and adapted

to the locality: Tartarian honeysuckle, lilac, highbush cranberry, common snowball, Siberian dogwood, hydrangea, *Spirea vanhouttei*, yellow currant, common elder, golden elder, cut-leaf elder, mock orange, and buckthorn. The buckthorn, while a good hardy shrub and particularly so for hedge purposes, can not be recommended, as it acts as a host for the oat rusts. Oats grown near this hedge for the last three years have been seriously damaged by rust.

DRY-LAND FARMING[5]

Experiments in crop production on dry land have been carried on at the Belle Fourche Experiment Farm since 1908. The staple crops of the region have been grown in different rotations and under various systems of tillage. These rotations and cultural methods are designed to establish the adaptation of the several crops to the region, the sequence in which the crops should be grown, and the methods of soil preparation that should be employed. There are in addition rotations containing fallow and rotations in which organic matter, either in the form of stable manure or a green-manure crop, is added to the soil.

CLIMATIC CONDITIONS INFLUENCING CROP PRODUCTION

The production of crops on dry land is largely influenced by climatic factors. The most important of these is precipitation, but temperature, evaporation, humidity, and wind velocity are important in determining crop yields. In only one year in the history of the farm has more water been added to the soil by precipitation than the growing crops were able to utilize. The effectiveness of the precipitation each year has been determined by its distribution and by the intensity of the other climatic factors. These several factors are not independent but are interrelated, and all are likely to be either favorable or adverse at the same time. For example, in years when the precipitation is sufficiently high and well distributed to meet the needs of the crop, the evaporation, wind velocity, and temperatures are likely to be low and the humidity high. In years when the precipitation is poorly distributed one or more of the other factors are likely to be unfavorable, and when the precipitation is low, evaporation, wind velocity, and temperatures are usually high and humidity low.

The extent to which the conditions brought about by unfavorable climatic factors may be ameliorated by cultivation determines the profitable limits of intensive cultivation in the production of dry-and crops.

ADAPTED CROPS

The crops on the dry-land areas of the station are grown in a number of rotations embracing different cultural methods and crop sequences. For most crops these include about an equal number of good and poor methods. The relative number of good and poor methods is not exactly the same for different crops; therefore the average yields are not strictly comparable. They are nearly enough so, however, to indicate the adaptation of the different crops to the region. The average yields each year of the more important crops are shown in Table 21.

[5] These experiments were conducted under the immediate supervision of O. R. Mathews, of the Office of Dry-Land Agriculture, Bureau of Plant Industry, who prepared this part of the report.

TABLE 21.—*Yields of winter wheat, spring wheat, barley, flax, oats, corn, and sorgo on dry land, 1909–1922*

[Yields are stated in bushels except for corn stover and sorgo, which are in pounds]

Crop	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Average
Winter wheat	28.9	1.8	0	0	21.3	18.2	36.2	12.7	3.8	27.1	2.0	1.6	5.4	30.8	13.6
Spring wheat	28.7	2.6	0	0	10.8	10.1	57.6	17.3	7.4	11.9	.9	29.9	7.3	32.2	15.5
Barley	31.7	3.0	0	.7	10.1	9.5	72.2	31.0	22.9	14.6	1.3	60.9	12.8	44.8	22.5
Flax	8.0	0	0	0	0	0	29.6	3.4	3.1	7.9	0	22.1	0	17.1	6.5
Oats	60.9	6.8	0	8.2	23.9	26.3	125.6	33.3	17.1	23.3	2.3	63.8	11.6	66.0	33.5
Corn:															
Grain	19.3	.6	0	21.9	8.6	.5	44.5	32.5	20.4	30.0	.3	37.4	9.0	42.3	19.1
Stover	3,305	2,839	0	2,623	986	1,115	2,785	2,198	1,969	2,977	235	2,008	1,435	3,069	1,967
Sorgo	5,920	3,360	0	4,100	3,400	1,725	6,450	9,500	3,300	7,700	0	5,900	2,450	5,950	4,268

The average yields of the several crops are no doubt higher than those obtained by most farmers, but they may be equaled or exceeded by farmers who use only the better crop sequences and cultural practices. The adaptation of the different groups of crops will be considered separately.

The average acre yields of the principal grain crops for the 14 years from 1909 to 1922, inclusive, have been as follows: Winter wheat, 13.6 bushels; spring wheat, 15.5 bushels; barley, 22.5 bushels; oats, 33.5 bushels; and flax, 6.5 bushels. In comparative value per acre spring wheat, oats, and barley have been nearly equal. As a rule they have shown about the same response to cultural methods. Choice between these crops depends upon the purpose for which they are produced. When a cash crop is desired wheat should be grown. When feed is desired oats or barley should replace wheat.

Flax is grown only on fall or spring breaking. It was a total failure in 7 of the 14 years for which results are given. Five of these failures occurred successively. Good yields were obtained only in years of exceptionally high rainfall. The chance of complete failure and the small likelihood of obtaining a good yield demonstrate that planting flax on fall or spring breaking is not advisable. Winter wheat has given a lower average yield than spring wheat. This has been due to partial winterkilling in several years and to a rust epidemic that practically destroyed the crop in 1920. In some years its yield has been materially higher than that of spring wheat. Winter rye is grown to a very limited extent. It has been a surer crop than winter wheat, as it has escaped winterkilling and rust damage. In good years its yield is lower than that of winter wheat.

The average yields of wheat, oats, and barley have been high enough to more than pay the cost of production. Study of the yield in individual years indicates why grain farming has not been successful in this region. Years of complete or nearly complete failure have occurred frequently. The fairly high average yield is the result of very high yields in a few years and yields below the average in most years. The years of failure have so depleted the farmer's capital that he has been unable to take advantage of the good years. Grain production alone offers little opportunity for success, but a limited acreage of grain in connection with livestock production should meet with a moderate degree of success.

CULTIVATED CROPS

Only two cultivated crops, corn and sorgo, have given promise of success on dry land in this section. The yield of corn has averaged 19.1 bushels of grain and 1,967 pounds of air-dry stover per acre. Sorgo has produced an average fodder yield of 4,268 pounds per acre. This yield might be discounted a little, because sorgo dries very slowly and in a few cases it was necessary to weigh the crop before it was thoroughly dry.

Both corn and sorgo have proved to be much surer crops than small grains. Years of total failure have been few, and in nearly all years at least a fair yield of stover has been obtained. Corn has not produced grain in all years, but the number of years having a good yield is higher than with small grain. This feature combined with the value of the stover for forage makes corn a crop well adapted to a farming practice in which livestock production is a major consideration. Sorgo occupies about the same place as corn. Its heavier stover weight makes up to a great extent for the absence of a grain yield. While sorgo is not likely to supplant corn to any great extent, a portion of the corn acreage might be planted to sorgo advantageously. It is noticeable that in years when no yield of ear corn has been obtained, sorgo has been the more valuable crop.

HAY CROPS

Alfalfa, bromegrass, and clover have been tried as hay crops in dry-land rotations. Clover has winterkilled at least half the time, and in years when there has been no winter damage it has yielded less than alfalfa. Alfalfa and bromegrass have both grown well but have demonstrated that they are not adapted to rotation use. Preparing the ground for these crops and getting a stand is expensive, because they must be sown without a nurse crop and little or no hay is obtained the first year. Yields of second-year alfalfa and bromegrass average about three-quarters of a ton per acre. All evidence at hand indicates that with alfalfa the older fields yield well so long as the stand remains good. Bromegrass is likely to become sod-bound after a few years, though it requires more time to reach that stage here than it does in more humid sections. Certainly neither bromegrass nor alfalfa when once established should be broken up as long as the production of the field remains good. Both of these crops leave the soil very dry, and crops immediately following them have generally been poor.

RESULTS FROM CROP ROTATIONS

Rotation up to the present time has shown no cumulative effects from the different crops and crop sequences. It is doubtful whether any residual effect of a crop other than the quantity of moisture left in the soil has influenced the yield of the succeeding crop. This is to be expected in the first few years of cultivation of a soil of high natural fertility in which production is limited chiefly by the water available. Small grains generally use all the available soil moisture in the soil. There is little difference between the several small grains either in their demands for moisture or in the yield of crops following

them. Yields of crops following corn generally have been above the average. This is no doubt largely due to the fact that corn normally does not reduce the moisture content of the soil to as low a point as do the small grains. It has been noted that when the corn crop is seriously injured by drought the yield of the crop following approximates that of the same crop after small grain.

The production of crops on fallow land or upon green-manured land is a combination of crop sequence and cultural methods. The resulting increase in yields due to the growth of crops on fallow or green-manured land has been found to be dependent on the moisture stored by these practices. Green-manure crops, such as rye, peas, or sweetclover, are usually plowed under in June and the land kept fallow the rest of the year. When the different green manures have been plowed under at different times the yields of succeeding crops have shown results in favor of the earlier plowing. As yet no response has been shown to either the quantity or character of the green matter turned under. Summer-fallowed land has been plowed in the fall or spring and kept free from weeds during the entire season. It affords the maximum opportunity for the storage of moisture, and as a result crops after fallow have yielded higher than those in any other sequence. That this is due primarily to moisture and not to fertility is indicated by the fact that yields on manured fallow have been no higher than on unmanured fallow.

Yields of wheat, oats, and barley in four principal crop sequences are shown in Table 22.

TABLE 22.—*Average yields of spring wheat, oats, and barley in four principal crop sequences on dry land for the 14-year period, 1909–1922*

Crop	Yields per acre (bushels) following—			
	Small grains	Cultivated crops	Fallow	Green manure
Spring wheat	13.4	14.9	20.1	15.4
Oats	28.9	33.2	44.2	33.4
Barley	20.7	23.7	30.3	----------

Application of the figures presented in Table 22 may be made as follows: Wheat after small grain yields 13.4 bushels per acre and after a cultivated crop, as, for example, corn, 14.9 bushels per acre. Choice between the two methods, not considering expense of cultivation or arrangement of labor, would depend upon whether two 13.4 bushel crops of wheat were more desirable than one 14.9 bushel crop of wheat and a crop of corn yielding 19.1 bushels of grain and 1,967 pounds of stover (Table 21). In the same way choice between wheat continuously and after fallow would depend upon whether a 13.4 bushel yield of wheat each year was more desirable than a 20.1 bushel yield on half as much land. Comparisons between any two methods may be made similarly. Of course, the labor of cultivation necessitated by any particular crop sequence and the distribution of labor it affords play an important part in determining which crop sequence may be most desirable.

RESULTS FROM CULTURAL METHODS

The effect of cultural practices upon the yield of the different crops has been found to be far smaller in the average of a series of years than is generally supposed. When seeding is done at the same time, the yield of grain after grain on spring plowing, fall plowing, subsoiling, and listing is practically the same. Choice between spring and fall plowing must depend upon the arrangement of the work and the condition of the soil rather than upon any superiority of one method over the other, either in moisture stored or resulting yield. Grain on fall plowing generally starts more vigorously in the spring than grain on spring plowing, but as the moisture supply during the growing season is the determining factor, this better early start is as frequently a handicap as it is an advantage. Subsoiling or deep tillage has shown no superiority over ordinary fall plowing. As it is a more expensive method of soil preparation it has no place in the agriculture of this section.

Where grain follows corn, yields on disked land have been as high as on land plowed in the spring or fall. As disking is a cheaper and quicker method of soil preparation, there seems to be no reason why corn ground should be plowed unless the growth of weeds or some similar cause makes disking impracticable.

Corn has shown to better advantage on fall plowing than on spring plowing. The margin of difference is small and is found in a slightly earlier maturity brought about by a better early start rather than in a measurable increase in yield. Corn planted with a lister on land not plowed has produced yields only a little lower than those obtained on plowed land. Listing is a cheaper method of producing corn than plowing, but it necessitates special machinery for cultivation.

Fall plowing has shown to particular advantage in the production of sorgo. Spring plowing often leaves the ground lumpy, and much difficulty is experienced in working it down sufficiently to form a seed bed good enough to insure uniform germination of sorgo seed. In general, it is easier to obtain a good stand of all small-seeded crops on fall plowing than on spring plowing.

The average yield of crops on summer fallow has been shown. The chief value that fallow could have, however, would be in its ability to ameliorate conditions in a poor season by a heavier production caused by moisture carried over from the fallow year. The extent to which fallow has been effective is shown in Table 23 by comparison of the yield of wheat on fallow with the yield of wheat after small grains in the individual year.

TABLE 23.—*Yields of spring wheat after fallow and after small grains on dry land, 1909–1922*

Method	Yields per acre (bushels)														
	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Average
After fallow	32.7	4.3	0	0	15.6	16.1	56.8	20.0	11.5	31.5	4.5	30.7	25.6	32.5	20.1
After small grains	27.6	.7	0	0	8.3	5.5	57.9	12.2	5.7	7.4	0	28.9	1.8	31.6	13.4

Wheat on fallowed land has yielded 50 per cent more on the average than wheat after small grain. This increase is not evidenced each year. In very bad years both methods fail. In very good years high yields are obtained from both. It is only in years of partial failure that growing wheat on fallowed land has materially increased yields.

The increase in yield on fallow is of more value than the average indicates. The fact that most of this increase is obtained in years of partial failure makes it more valuable than if it were evenly distributed.

Where fallow is used, only half of the land is in crop each year. Whether the greater stability due to a better distribution of yield makes up for the smaller total production of wheat on fallow must determine the extent to which the practice is justified.

UTILIZATION OF DRY LAND IN CONNECTION WITH IRRIGATION

It is recognized that the greater portion of the dry land within the Belle Fourche Reclamation Project will be used for pasture. Where there are no irrigated grass pastures, the dry land generally must be utilized in this way.

The result of the dry-land work at the experiment farm indicates what may be expected from crop production on such land not required for pasture.

At the experiment farm the dry land not otherwise used has been planted to oats and corn or sorgo in a two-year rotation, consisting of corn or sorgo on fall plowing and oats on disked corn or sorgo ground. In most years the net return from this rotation has been materially higher than the value of the land as pasture.

UTILIZATION OF CROPS BY LIVESTOCK

PASTURING ALFALFA WITH HOGS

In connection with the irrigated rotation experiments previously described, the third-year crop of alfalfa is pastured with hogs in two rotations. One is rotation No. 65 and the other rotation No. 69. Rotation No. 65 consists of three years of alfalfa followed by corn, flax, and oats, one year each. Rotation No. 69 consists of three years of alfalfa, two crops of corn, and one of oats. The third-year alfalfa and one crop of corn in each rotation are pastured with hogs. The hogs while on alfalfa are fed 2 pounds of corn daily for every 100 pounds of live weight. Each of the two alfalfa plats pastured with hogs is divided into two lots and pastured alternately, the hogs being changed every two weeks. This arrangement allows for more uniform growth of alfalfa and convenience in irrigating.

The pasture season is divided into two periods—the spring period from early May to July, when fall pigs are used, and the summer period from July to September, when spring pigs are used.

Changing from fall pigs to spring pigs about July 1 can not be recommended as a farm practice. When this experiment was begun the object in view was to obtain the largest quantity of pork to the acre of alfalfa pasture. In later years the local problem seems to be to obtain the cheapest gains for the grain fed, utilizing alfalfa pasture as a supplementary feed. To do this the sows and their litters must be turned on pasture early in the spring, and fall pigs can be

finished with less grain while on alfalfa pasture than in the dry lot. This will be considered more in detail later in this report.

The results for the season of 1922 are as follows: On May 17 five fall pigs averaging 111.5 pounds in weight were turned on each rotation plat and pastured until July 12. During this 56-day period the pigs in rotation No. 65 gained 255 pounds, while those in rotation No. 69 gained 249 pounds. On July 13 seven spring pigs averaging 41.5 pounds were put on each rotation plat and pastured until September 9. The alfalfa pasture was still in good condition, but as the corn was ripe the remaining pasture was utilized together with the corn. During this 58-day pasturing period the pigs on rotation No. 65 gained 216.5 pounds and those on rotation No. 69 gained 234 pounds. The total pasturing period was 114 days. Calculating the results on an acre basis, in rotation No. 65 the average live weight per acre was 2,156 pounds, the corn fed per acre 4,908 pounds, and the total gains per acre 1,886 pounds. It took 2.6 pounds of corn to make 1 pound of gain. In rotation No. 69 the average live weight per acre was 2,168 pounds, the grain fed per acre 4,908 pounds, and total gains made per acre 1,932 pounds. It required 2.54 pounds of corn to make 1 pound of gain. The results of pasturing alfalfa in rotation No. 65 for 10 years and in rotation No. 69 for 8 years are shown in Table 24.

TABLE 24.—*Results of pasturing alfalfa with hogs during stated periods, 1913–1922*

Year	Rotation No.	Time in pasture (days)	Pounds per acre			Grain fed per pound of gain (pounds)
			Average live weight	Grain fed	Gains made	
1913	65	94	1,808	4,292	1,068	4.02
1914	65	121	1,815	5,104	1,830	2.79
1915	65	132	2,002	4,787	2,024	2.37
1915	69	132	2,060	4,976	2,108	2.36
1916	65	119	2,286	5,290	1,962	2.70
1916	69	119	2,238	5,128	2,006	2.56
1917	65	119	1,956	4,504	1,742	2.59
1917	69	119	1,956	4,464	1,740	2.57
1918	65	121	1,934	4,880	1,942	2.51
1918	69	121	1,979	4,880	2,138	2.28
1919	65	109	2,072	4,444	1,714	2.59
1919	69	109	2,062	4,444	1,688	2.63
1920	65	122	2,124	5,228	2,024	2.58
1920	69	122	2,124	5,228	2,032	2.57
1921	65	118	1,945	4,776	1,942	2.46
1921	69	118	1,964	4,776	2,004	2.38
1922	65	114	2,156	4,908	1,886	2.60
1922	69	114	2,168	4,908	1,932	2.54
Average for rotation No. 65 (10 years)		116.9	2,009.8	4,821.3	1,813.4	2.72
Average for rotation No. 69 (8 years)		119.25	2,068.88	4,850.5	1,956.0	2.49

HOGGING CORN

On September 22, 1922, five spring pigs with an average initial weight of 74 pounds were turned on the quarter-acre plat in rotation No. 65. A careful estimate made before the hogs were turned into the plat indicated a yield of 68.1 bushels per acre. The same system for determining corn yields was used on plats actually harvested, and the widest variation in no case was more than 2 bushels between the estimated yields and the yields harvested. The hogs cleaned up the

corn in 37 days, and during this time they gained 240.5 pounds, or at the rate of 962 pounds per acre. Nine pigs with an average initial weight of 73.5 pounds were turned on the half-acre plat in rotation No. 69 on September 22, 1922. This plat was estimated as yielding 68.9 bushels of corn per acre, and the hogs cleaned up the corn in 37 days. During this period they gained 517.5 pounds, or at the rate of 1,035 pounds per acre.

On this basis of 68.1 bushels of corn per acre in rotation No. 65 and 68.9 bushels in rotation No. 69 it required 3.96 pounds of corn to make a pound of gain in rotation No. 65 and 3.73 pounds in rotation No. 69. The pigs made an average daily gain of 1.3 and 1.55 pounds, respectively, in rotations Nos. 65 and 69. In both rotations the pigs had access to alfalfa plats pastured during the summer.

Table 25 shows the results of hogging corn for 11 years in rotation No. 65 and for 8 years in rotation No. 69.

TABLE 25.—*Results of harvesting corn with hogs during stated periods, 1912–1922*

Year	Rotation No.	Length of test	Per acre basis: Live weight when turned on	Per acre basis: Gain	Per acre basis: Estimated corn yield	Corn fed per pound of gain	Average: Initial weight	Average: Gain per day
		Days	*Pounds*	*Pounds*	*Bushels*	*Pounds*	*Pounds*	*Pounds*
1912	65	26	680	340	28.7	4.7	85	1.63
1913	65	11	1,632	560	34.0	3.4	51	1.59
1914	65	20	1,708	582	34.8	3.3	106	1.82
1915	65	15	1,620	548	40.6	4.1	81	1.83
1915	69	10	1,780	451	34.0	4.2	89	2.26
1916	65	24	1,252	518	59.1	6.4	104	1.80
1916	69	26	1,268	456	47.7	5.9	105	1.46
1917	65	30	1,280	682	67.4	5.5	108	1.89
1917	69	37	1,206	537	55.4	5.8	109	1.38
1918	65	33	1,530	758	55.8	4.1	95	1.44
1918	69	35	1,190	667	56.7	4.8	99	1.59
1919	65	32	1,342	642	40.9	3.6	67	1.00
1919	69	32	998	554	40.0	4.0	62	1.08
1920	65	19	1,486	682	42.8	3.5	74	1.79
1920	69	28	1,025	703	43.6	3.5	73	1.79
1921	65	32	1,240	1,034	63.7	3.4	77	2.02
1921	69	26	1,087	866	52.7	3.4	77	2.38
1922	65	37	1,480	962	68.1	4.0	74	1.30
1922	69	37	1,323	1,035	68.9	3.7	73.5	1.55
Average for rotation No. 65 (11 years)	------	25.36	1,386.36	664.36	48.72	4.18	83.82	1.65
Average for rotation No. 69 (8 years)	------	28.88	1,234.63	658.63	49.88	4.42	85.94	1.68

HARVESTING ALFALFA, CORN, AND BEET TOPS WITH SHEEP

PASTURING ALFALFA WITH EWES AND LAMBS

Rotation No. 71 covers six years—three years of alfalfa and one year each of corn, sugar beets, and oats. The third-year alfalfa is pastured with ewes and their lambs, the corn and beet tops with lambs only. While pasturing the corn, the lambs have access to the alfalfa pastured during the summer and later to the beet tops. (Fig. 8.) This rotation was started in 1916 and with the crop season of 1922 has been in operation for seven years. In 1916 the alfalfa was overpastured, and this materially reduced the gains of the lambs. Table 26 shows the results of pasturing alfalfa with ewes and lambs from 1916 to 1922, inclusive.

TABLE 26.—*Results of pasturing ewes and lambs on alfalfa, 1916–1922*

Year	Number of head		Average initial weight (pounds)		Period on pasture (days)		Average gain of lambs (pounds)	
	Ewes	Lambs	Ewes	Lambs	Ewes	Lambs	Daily	Per acre
1916	12	12			87	87	0.23	240
1917	8	16	128	35	80	80	.30	380
1918	8	12	140	33	82	112	.30	405
1919	8	12	120	30	74	74	.57	512
1920	8	12	127	46	59	103	.45	560
1921	8	12	153	49	46	106	.41	528
1922	8	12	136	41	56	101	.30	372
Maximum	12	16	153	49	87	112	.57	560
Minimum	8	12	120	30	46	74	.23	240
Average			134	39	69.1	94.7	.366	428.1

FIG. 8.—Spring lambs in alfalfa pasture rotation No. 71 on the Belle Fourche Experiment Farm, September, 1916

The sheep and their lambs have generally been turned on the alfalfa pasture about May 15 or 20. The average weight of the ewes when turned on has been 134 pounds and of the lambs 39 pounds. The first year 12 ewes and 12 lambs per acre were used, but this proved to be too many. For the last five years the rate has been 8 ewes and 12 lambs per acre. At this rate there has been ample pasture for the ewes and their lambs up to July 25, when the ewes have been taken out, and for the lambs alone for the remainder of the season. They have been turned into the corn about September 1. The average number of days for 1 acre of alfalfa pastured for seven years is 69.1 for 8 ewes and 94.7 for 12 lambs. The ewes while in the alfalfa pasture have maintained their weight and in some cases have gained. The average daily gains for the lambs for the seven years have been 0.366 pound, and the average number of pounds gained per acre is 428.1.

PASTURING CORN AND BEET TOPS WITH LAMBS

The lambs have generally been turned into the corn about September 1. (Figs. 9 and 10.) While the corn as a rule is not ripe until September 15, it has seemed desirable to turn them in this early to clean up weeds and the leaves of the corn. Very often they will eat the husks from the ears before they begin to eat the grain. The beets are generally harvested from October 1 to 15, after which the lambs have access to the beet tops. Table 27 shows the results of pasturing corn with lambs from 1916 to 1922, inclusive. While pasturing the corn they have had access to alfalfa pasture and beet tops.

FIG. 9.—Corn in rotation No. 71 just before turning in the lambs. Belle Fourche Experiment Farm, September, 1916

TABLE 27.—*Results of pasturing corn with lambs, 1916–1922*

Year	Number of lambs	Number of days	Average initial weight	Yield per acre	Corn fed to make 1 pound of gain	Gain per acre	Average daily gain
			Pounds	*Bushels*	*Pounds*	*Pounds*	*Pounds*
1916	40	62	65	52.0	4.9	600	0.24
1917	48	42	72	57.0	4.4	724	.36
1918	32	60	72	55.0	5.1	600	.31
1919	32	42	71	30.0	3.4	496	.37
1920	28	43	65	42.0	5.3	440	.37
1921	24	63	91	53.0	5.6	528	.35
1922	40	73	47	60.0	6.3	536	.18
Maximum	48	73	91	60.0	6.3	724	.37
Minimum	24	42	47	30.0	3.4	440	.18
Average	35	55	69	50.0	5.0	561	.31

The average number of lambs pastured per acre was 35, their average initial weight 69 pounds, and the average yield per acre of corn 50 bushels. The lambs consumed 5 pounds of corn for each pound of gain. The average daily gain was 0.31 pound and the average gain per acre 561 pounds. Farmers on the project who have

harvested their corn with lambs are very much in favor of this practice. During the seven years that sheep have been pastured on alfalfa there have been no losses from bloat at the experiment farm. There is danger from bloat when pasturing sheep on alfalfa, but it has not been serious on the project. Farmers who make a practice of pasturing alfalfa on a large scale report that their losses from bloat are no larger proportionally than they have from other causes on the range, where sheep are run in larger numbers. Harvesting alfalfa and corn with hogs or sheep gives good results in this region. On the heavy gumbo soils alfalfa harvested for hay has shown very little beneficial effect on the crops that follow. In rotations Nos. 65 and 69, where alfalfa has been pastured with hogs, the yield of corn following the pastured alfalfa has been materially increased, and the same is true in rotation No. 71, where sheep are used for pasturing the alfalfa, corn, and beet tops. The yields of sugar beets following the pasturing of corn have always been satisfactory, and in 1922 the beets after corn pastured with sheep gave the highest yield (20.8 tons per acre) of all the plats in the rotations. (See Table 10.)

FIG. 10.—Corn in rotation No. 71, pastured with spring lambs. Belle Fourche Experiment Farm, 1916

The saving of labor and improvement in the crops that follow are the most important points in favor of harvesting certain farm crops with livestock. For this purpose a seven-year rotation may be recommended, four years of alfalfa, the fourth year being pastured, followed with two years of corn pastured at least one year, or one year of corn pastured, followed with sugar beets, followed with grain, and then seeded back to alfalfa.

PASTURE GRASSES

The future welfare of the Belle Fourche project depends on the successful establishment of livestock industries. Some pasture must be provided during the summer months for the livestock that is kept on the farm throughout the year. This applies especially to dairy cows. Irrigated pastures are of a permanent nature, and while the cost of establishing them is somewhat high the subsequent cost

of care is not great. For the maximum results the pasture should be located on the best available ground not only as to fertility but also as to ease of irrigation.

In the experiment with mixed-grass pastures on the Belle Fourche Experiment Farm eight different mixtures of seed have been used. The composition of these mixtures and the rate of seeding are shown in Table 28.

TABLE 28.—*Rate of seeding mixtures of grass seed for pasture, 1915 and 1916*

Kind of seed	Seed per acre (pounds)							
	Planted in 1915				Planted in 1916			
	Mixture A	Mixture B	Mixture C	Mixture D	Mixture 1	Mixture 2	Mixture 3	Mixture 4
Kentucky bluegrass	4	4	4	20	3	5		
Bromegrass	2	2	2		4		6	6
Meadow fescue	2	2	2		6	10		
Orchard grass	6	6	6		5			
Tall oatgrass	2	2	2		6	2	10	6
White clover		2	2		2		2	
Sweetclover								6
Alsike clover		2	2					
Alfalfa			3	3				
Timothy	4	4	4					
Tall fescue	2	2	2					
Redtop	4	4	4					
Italian ryegrass	2	2	2					
Slender wheatgrass	2	2	2	12				
Perennial ryegrass	2	2	2					
Total	32	36	39	35	26	17	18	18

Mixtures A, B, C, and D were planted in the spring of 1915 and mixtures 1, 2, 3, and 4 in 1916. The mixtures in 1915 were planted with a nurse crop of oats and in 1916 with a nurse crop of barley. The nurse crop was clipped early, and good stands were obtained on all plats. The plats were not pastured the first year.

The plats seeded in 1915 have been pastured with dairy cows since 1916. The results in terms of milk and butterfat produced, the number of days of feed per cow, and the pasture furnished per acre are shown in Table 29.

TABLE 29.—*Results of pasturing cows with four pasture mixtures, 1916–1921*

Production per acre and mixture	1916	1917	1918	1919	1920	1921	Average
Milk (pounds):							
A	3,124	2,462	1,553	1,438	1,805	1,436	1,970
B	2,512	2,888	2,499	1,371	1,748	3,730	2,458
C	3,656	3,401	3,529	2,816	1,274	2,884	2,927
D	2,598	3,459	4,706	5,516	3,813	4,234	4,054
Butterfat (pounds):							
A	124.1	110.7	76.8	57.5	72.2	57.4	83.1
B	94.4	129.9	122.4	54.8	69.9	149.2	103.4
C	144.5	153.0	172.9	112.6	50.9	115.3	124.9
D	105.1	137.6	213.2	207.2	133.4	169.3	161.0
Cow days per year:							
A	136	64	80	108	104	112	101
B	112	64	128	112	72	132	103
C	160	80	180	188	132	172	152
D	180	140	208	148	123	118	153

Mixture D shows the largest carrying capacity for the first three years, but for the three years 1919–1921 this decreased so that in 1921 mixture C gave 172 days of pasture for one cow and mixture D only 118. This is proof that a permanent pasture mixture should not be made up largely of one species of grass but that a variety of grasses will give better results. The number of cow days that the pasture was used is much more reliable as a measure of value than the production of the cows, as is shown in Table 29, as the difference in milk and butterfat production was probably due less to differences in the pastures than to different stages in the lactation of the cows through the season. Good grade Holstein cows were used, producing from 400 to 500 pounds of butterfat a year. No grain or supplemental feeds were used while the cows were on pasture.

The pasturing of the mixtures planted in 1916 was begun on May 29, 1917. No milk cows were available, so five grade Holstein heifers, 6 to 12 months old, with an average initial weight of 380 pounds, were used. The results are shown in Table 30.

TABLE 30.—*Results of pasturing five heifers on four pasture mixtures in 1917*

Mixture	Area (acre)	Pasture afforded (days)		Gain per acre (pounds)
		Per heifer	Per acre	
No. 1	0.50	89	178	340
No. 2	.50	103	206	500
No. 3	.50	88	176	400
No. 4	.25	127	508	500

There was very little difference in the number of days of pasturing and the total live weight carried per acre in mixtures Nos. 1 to 3, inclusive. While the carrying capacity of mixture No. 4 was very nearly three times as great as the other mixtures, the total gains made per acre with No. 4 were as good as with any other mixture, but the average daily gain was less.

Milk cows to pasture in a systematic way have not been available for mixtures Nos. 1, 2, 3, and 4, but from results obtained with young stock and dry cows they have shown a better carrying capacity than mixtures A and B and have compared favorably with mixtures C and D.

To get the maximum carrying capacity of a pasture mixture it is necessary to include some of the clovers, about 2 pounds of each, and 1 to 2 pounds of alfalfa. During the six years that this test has been carried on there has been no trouble from bloat where 2 pounds of white clover and alsike clover or alfalfa have been included in the mixture. Sweetclover can not be considered as part of a permanent pasture mixture, but it might be included so as to give a larger carrying capacity during the first year until the grasses are established. Where sweetclover is used alone for pasture it is necessary to follow a rotation of corn, grain (seeded to sweetclover), and pasture for one year.

ESTABLISHING GRASS PASTURES

The best land preparation for establishing a permanent grass pasture is good clean corn ground, disked, leveled, and harrowed before planting. The planting may be done in the spring with a nurse crop of grain. The nurse crop may be kept clipped during the summer rather than harvested for grain. If clipped, a much better growth of the grasses will be made and the pasture will be more productive the following year. The easiest and safest way to insure a stand is to plant in the stubble after the grain has been removed. If this method is followed the grain should be planted as early as possible in the spring, in order to get it out of the way, and the grass planted as early in August as possible. Whatever method is used the land must be irrigated frequently if the best results are to be obtained.

The various grasses used in the mixtures were also planted separately in 1915 in order to observe their behavior as to growth and also to see if the stock showed any special preference for any of the varieties used. When first turned in the cows seemed to show a slight preference for alfalfa, timothy, and bromegrass, but later on they grazed about the same on all the plats. The only grass they refused to eat was the tall fescue. This test was repeated three times during two different summers with about the same results.

For a permanent grass pasture the following mixture is recommended: Bromegrass, Kentucky bluegrass, orchard grass, meadow fescue, and western wheatgrass, 5 pounds each; 2 pounds of white clover; 1 pound of alfalfa, and, if desired, 5 pounds of sweetclover, making a total of 33 pounds per acre. This may seem a high rate per acre, but the success of a permanent pasture depends first on getting a good stand, and this can be better accomplished with a heavy rate of seeding, provided other conditions are right. The mixture may be planted with a grain drill or sown broadcast and harrowed lightly. In either case, care must be taken not to cover the seed too deeply. Where sown in the grain stubble, planting with a grain drill is the most satisfactory method. To obtain a maximum carrying capacity on grass pastures they should be given an application of manure every fall or winter and harrowed with a spring tooth in the spring. The pasture should be divided into two parts and the stock changed every two or three weeks. This should be followed with an irrigation as soon as the stock is changed from one pasture to another. The grasses used in the mixture are not deep rooted, and frequent irrigations should be practiced to keep them in the best growing condition all through the summer.

EXPERIMENTS WITH HOGS[6]

In cooperation with the Animal Husbandry Division of the Bureau of Animal Industry, some experiments with hogs were started on the Belle Fourche Experiment Farm in 1917. These experiments include the use of different grain rations as supplements to alfalfa pasture for hogs, the winter feeding of fall pigs, maintenance rations for brood sows, and hogging-off corn.

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[6] This work was under the immediate supervision of S. H. Bober, who assisted in the preparation of this part of the report.

ALFALFA PASTURE FOR SPRING PIGS SUPPLEMENTED BY VARIOUS GRAIN RATIONS

The objects of this experiment are to study the effects of feeding different concentrates to spring pigs on alfalfa pasture and to compare the hand-fed 2 per cent ration with self-feeding on pasture. Five plats of alfalfa pasture each containing three-eighths of an acre were used, as follows:

Lot 1, 6 pigs, alfalfa pasture and 2 per cent corn.
Lot 2, 9 pigs, alfalfa pasture and 2 per cent corn, May 23 to August 13, and corn in self-feeder from August 13 to September 18.
Lot 3, 12 pigs, alfalfa pasture and shorts in self-feeder.
Lot 4, 12 pigs, alfalfa pasture and ground barley in self-feeder.
Lot 5, 12 pigs, alfalfa pasture and corn in self-feeder.

All of the 51 pigs used in this test were purebred Duroc-Jerseys. The experiment was begun on May 23, 1919, and ended on September 18, a period of 118 days.

The average gains per pig for the period of this test were 56 pounds in lot 1, 71 pounds in lot 2, 118 pounds in lot 3, 135 pounds in lot 4, and 110 pounds in lot 5.

The pigs in lots 1 and 2 were in good shape to be sold as feeder hogs, while the pigs in the self-feeder lots could have been finished off for market in another four weeks in the dry lot or in the cornfield.

Pigs in lot 4, where ground barley was fed in a self-feeder, showed the maximum development and made the quickest gains. Pigs in lot 3, where shorts were fed in the self-feeder, showed slightly better development than pigs self-fed on corn in lot 5.

The feed consumed per 100 pounds of gain was as follows: 241 pounds of corn in lot 1, 290 pounds of corn in lot 2, 387 pounds of shorts in lot 3, 374 pounds of ground barley in lot 4, and 353 pounds of corn in lot 5.

The advantages for the self-fed pigs are that they can be marketed sooner and returns received more quickly, that there is less risk when hogs reach marketable weight quickly, that self-feeding eliminates a good deal of labor, and that a larger number of pigs and of pigs of different sizes can be carried in one lot where the self-feeder is used, thereby saving on fencing. Where pigs are hand-fed they must be graded as to size and limited in number.

The disadvantages are that feed requirements per unit of gain increase as the pigs increase in weight and that most hog raisers in western South Dakota would have to buy a good share of the feed at central market prices with the cost of freight added, since the quantity of grain raised locally is not sufficient to finish a large number of hogs for market. Another objection is that by the time these spring pigs are finished the market price is often rather low.

It is only in exceptional years when market prices are relatively high that it pays to use the self-feeder and finish the hogs for market. In an average year the limited ration on alfalfa pasture producing a feeder pig will return the Belle Fourche farmer more money.

The actual net returns for the gain made in this test were low compared with the net returns in former years. This is due to the high prices of feed and the low market price for hogs at the time this test was made. A summary of results is presented in Table 31.

TABLE 31.—*Results of pasturing spring pigs on alfalfa with various grain supplements for 118 days, from May 23 to September 18, 1919*

Items of comparison	Supplemental grain ration				
	Lot 1, 2 per cent corn	Lot 2, 2 per cent corn[1]	In self-feeder		
			Lot 3, shorts	Lot 4, ground barley	Lot 5, corn
Number of pigs in lot	6	9	12	12	12
Average weight per pig:					
Initial ... pounds	28	28	28	28	28
Final ... do	84	99	146	163	138
Gain ... do	56	71	118	135	110
Daily gain ... do	.47	.60	1.00	1.14	.93
Gains per acre ... do	896	1,704	3,776	4,320	3,520
Grain fed per acre ... do	2,160	4,946	14,612	16,160	12,426
Grain fed per 100 pounds of gain ... do	241	290	387	374	353
Financial statement:					
Value of gains per acre with pork @ $13	$116.48	$221.52	$490.88	$561.60	$457.60
Value of grain fed per acre: Corn @ $3.50, shorts @ $2.25, and barley @ $2.75	75.60	173.11	328.77	444.40	434.91
Value of 1 acre of alfalfa pasture	20.00	20.00	20.00	20.00	20.00
Net returns from gains of 1 acre of alfalfa	20.88	28.41	142.11	97.20	2.69
To produce 100 pounds of gain—					
Cost of grain	8.44	10.16	8.71	10.29	12.36
Cost of pasture	2.23	1.17	.53	.46	.57
Total cost of feed	10.67	11.33	9.24	10.75	12.93
Returns from 100 pounds of gain less cost of feed	2.33	1.67	3.76	2.25	.07

[1] Lot 2 consisted of 2 per cent corn from May 23 to Aug. 13; corn in self-feeder from Aug. 13 to Sept. 18.

FEEDING FALL PIGS FROM WEANING TO MARKETABLE SIZE

An experiment was started on January 3, 1921, to study the feed cost and time required to raise a fall pig when fed on limited grain rations, supplemented with alfalfa hay and half-sugar beets during winter and early spring months, followed by alfalfa pasture during the spring and summer months.

In this test 24 purebred Duroc-Jersey pigs were used. These were farrowed between September 25 and October 7, and at the beginning of the test their average age was 94 days and their average weight 39.5 pounds. They were fed 2 per cent shelled corn, 3 per cent half-sugar beets, and third-cutting alfalfa hay in a self-feeding rack. This ration was fed daily until May 27, except that half-sugar beets were not available after April 11.

During the above 145-day feeding period the pigs made an average daily gain of 0.42 pound per head and at the end of this period averaged 100 pounds in weight. They were in excellent shape to be used as feeders on alfalfa pasture. Table 32 shows the results of the test for this 145-day feeding period.

TABLE 32.—*Results of winter feeding of fall pigs in 1921*

Number of pigs	24	Feed consumed per pound of gain:	
Average initial weight:		Shelled corn ... pounds	3.09
On Jan. 3 ... pounds	39.5	Half-sugar beets ... do	2.28
On May 27 ... do	100.00	Alfalfa hay ... do	2.34
Average daily gain per pig ... do	.42		

On May 27 the 24 pigs were divided into two lots as follows: Lot 1, 10 pigs on alfalfa pasture, receiving 2 per cent shelled corn daily, lot 2, 14 pigs on alfalfa pasture, receiving 1 per cent shelled corn daily to June 24, then 1½ per cent shelled corn daily to August 5, then 2 per cent shelled corn daily to August 19.

The reason for starting lot 2 on a 1 per cent ration and increasing it later to a 1½ and 2 per cent ration of corn was to find out whether more economical gains could be made by feeding pigs in this way than by a straight ration of approximately 2 per cent like that fed to pigs in lot 1.

It was assumed that pigs would make up on alfalfa pasture for less grain in the daily supplemental ration, especially during the early summer months when the growth of the alfalfa is most rapid.

On August 19 the limited daily grain ration was changed to full feed, shelled corn in self-feeders for both lots. The pigs were on full feed for 14 days, until September 2. On this date the pigs in lot 1 averaged 220 pounds per head, while the average weight of lot 2 was 217 pounds.

The average daily gain during the 84-day pasturing period with a limited grain ration was 1.03 pounds for pigs in both lots. The average daily gain during the last 14 days of the pasturing test, when both lots had access to shelled corn in a self-feeder, was 2.36 pounds for pigs in lot 1 and 2.18 pounds for pigs in lot 2.

The feed cost per 100 pounds of gain on pasture when the grain ration was limited was 278 pounds of corn for pigs in lot 1 and 200 pounds of corn for pigs in lot 2. During the 14-day self-feeding period the feed cost per 100 pounds of gain was 368 pounds of corn in lot 1 and 370 pounds of corn in lot 2. Table 33 shows the results of feeding the two lots for 98 days on alfalfa pasture.

TABLE 33.—*Results of feeding a 2 per cent corn ration to fall pigs on alfalfa pasture in comparison with a 1 per cent ration which was gradually increased to 2 per cent, both lots being self-fed corn, for the 14 days from August 19 to September 2, 1921*

Items of comparison	Corn ration on alfalfa pasture					
	Lot 1, 10 pigs			Lot 2, 14 pigs[1]		
	2 per cent corn	Corn in self-feeder	Full period	Corn	Corn in self-feeder	Full period
Dates of test	May 27 to Aug. 19	Aug. 19 to Sept. 2	May 27 to Sept. 2	May 27 to Aug. 19	Aug. 19 to Sept. 2	May 27 to Sept. 2
Length of test ... days	84	14	98	84	14	98
Average initial weight ... pounds	100.5	187	100.5	100	186.5	100
Average final weight ... do	187	220	220	186.5	217	217
Average daily gain per pig ... do	1.03	2.36	1.22	1.03	2.18	1.19
Corn consumed per 100 pounds of gain ... pounds	278	368	303	200	370	245

[1] The grain ration of lot 2 consisted of 1 per cent corn up to June 24, 1½ per cent corn to August 5, 2 per cent corn to August 19, and corn in self-feeder until September 2.

Table 33 shows that the pigs in lot 2 consumed 78 pounds of corn less than the pigs in lot 1 in order to make 100 pounds of gain while on the limited supplemental grain ration.

As long as alfalfa pasture is plentiful and alfalfa hay low in price, a 1 per cent grain ration on pasture, gradually increased as the season advances, may produce the same gains on fall pigs as a straight 2 per cent grain ration.

Table 34 shows the approximate feed cost exclusive of alfalfa pasture and hay to carry a fall pig to marketable size; also the time required to grow the pig from birth to the weight of 220 pounds when raised on a limited ration.

TABLE 34.—*Feed cost to grow a fall pig from birth to a marketable size of 220 pounds in 1921*

Items of comparison		Lot 1	Lot 2
Feed consumed during:			
Suckling period[1]	pounds	160	160
Winter and early spring dry-lot feeding—			
Corn	do	187	187
Beets	do	139	139
Pasturing alfalfa, limited grain	do	240	174
Finishing period, full feed on pasture	do	122	114
Total feed consumed—			
Corn	do	709	635
Half-sugar beets	do	139	139
Life history of pigs:			
Average date of birth		Oct. 2	Oct. 2
Date weaned and put on test		Jan. 3	Jan. 3
Beginning of pasturing period		May 27	May 27
Beginning of finishing period		Aug. 19	Aug. 19
Date marketable weight was reached		Sept. 2	Sept. 2
Time required for a fall pig to reach 220 pounds weight	days	336	336

[1] The approximate feed expenditure per weaned pig is figured on the basis of two litters a year, with six pigs to the litter. The 150 pounds of feed represents one-sixth of the grain consumed by the sow during the gestation and suckling periods plus the grain consumed by a pig in the "creep."

While 336 days may be rather long to raise a fall pig to marketable size, this period can not be materially shortened when alfalfa hay and pasture are to form the chief feed. During favorable times when the prices of grain and hogs permit the use of grain in a self-feeder, the time required for a fall pig to reach marketable size may be cut down as much as 100 days.

TANKAGE COMPARED WITH ALFALFA HAY AS A PROTEIN SUPPLEMENT

In 1922 an experiment was conducted to determine the feed cost of gains of fall-farrowed pigs and the relative value of tankage and alfalfa hay when fed as supplements with a limited grain ration in winter feeding.

On January 3, 1922, 13 purebred Duroc-Jersey pigs were divided into two lots and fed daily rations as follows:

Lot 1, six pigs averaging 50 pounds, fed 2 pounds of corn tankage (10 parts of corn to 1 part of tankage) and 3 pounds of half-sugar beets daily per 100 pounds of weight.

Lot 2, seven pigs averaging 48 pounds, fed 2 pounds of corn and 3 pounds of half-sugar beets per 100 pounds of weight, with access to alfalfa hay in a rack.

The corn fed was of good quality. The tankage was 60 per cent protein. The beets were of good quality until the middle of March, when they began to spoil. The alfalfa hay used was from the third cutting and of good quality.

The experiment ended on May 17, 1922. During the 134-day feeding test the pigs in lot 1 made an average daily gain of 0.38 pound

per head, using 3.70 pounds of corn, 0.37 pound of tankage, and 5.55 pounds of half-sugar beets per pound of gain. The pigs in lot 2 made an average daily gain of 0.51 pound per pig, using 3.08 pounds of corn, 2.94 pounds of alfalfa, and 4.56 pounds of half-sugar beets per pound of gain.

Figuring corn at $1 per 100 pounds, the third cutting of alfalfa at $10 per ton, tankage at $4 per 100 pounds, and half-sugar beets at $5 per ton the actual cost of the gains would be $6.56 per 100 pounds in lot 1 and $5.69 per 100 pounds in lot 2.

The pigs in lot 2 were much thriftier at the end of the experiment and seemed also to be of somewhat larger size.

Almost every farm on the Belle Fourche project can put up alfalfa hay of good quality from the third or fourth cutting, which is a much more economical protein supplement than tankage. Especially is this true in the production of feeder hogs where a limited grain ration is fed and alfalfa is necessary to make up the bulkiness of the ration. Table 35 shows the summary of the results of this experiment.

TABLE 35.—*Results of winter feeding of fall-farrowed pigs in 1922*

Items of comparison	Kind of ration		Items of comparison	Kind of ration	
	2 per cent corn, tankage, and 3 per cent beets	2 per cent corn, 3 per cent beets, and alfalfa hay		2 per cent corn, tankage, and 3 per cent beets	2 per cent corn, 3 per cent beets, and alfalfa hay
Number of pigs	6	7	Daily gain per pig ... pounds	0.38	0.51
Dates of test	Jan. 3 to May 17	Jan. 3 to May 17	Feed per pound of gain:		
			Corn ... pounds	3.70	3.08
			Tankage ... do	.37	----------
Length of test ... days	134	134	Alfalfa ... do	----------	2.94
Initial weight per pig ... pounds	50	48	Beets ... do	5.55	4.56
Final weight per pig ... do	100.5	116.5			

VARYING GRAIN RATIONS FOR SPRING PIGS ON ALFALFA PASTURE

An experiment was conducted in 1921 to determine the effect of feeding varying grain rations to spring pigs on alfalfa pasture and after the pasturing season to see what effects the restricted grain ration had on the feed cost of finishing the pigs for market.

Purebred Duroc-Jerseys were used, 28 spring pigs being divided into lots as follows:

Lot 1, 10 pigs on alfalfa pasture, receiving 1 per cent shelled corn daily.
Lot 2, 9 pigs on alfalfa pasture, receiving 2 per cent shelled corn daily.
Lot 3, 9 pigs on alfalfa pasture, receiving 3 per cent shelled corn daily.

The pigs were farrowed between March 15 and April 15. While there were some differences in the age and size of the pigs used, the lots were made as nearly alike as possible.

The feeding was done regularly once a day in the morning. Each lot was provided with an A-shaped house for shade and shelter.

The pasture plats contained more alfalfa than was necessary during summer months. This permitted mowing, to keep the pasture free from weeds and tough woody alfalfa.

This test was begun on June 2, 1921, and ended on October 6, the length of the period being 126 days. The average gain per pig for the period of this test was 52 pounds in lot 1, 80 pounds in lot 2, and 115 pounds in lot 3. The daily gain per pig was 0.41 pound in lot 1, 0.63 pound in lot 2, and 0.91 pound in lot 3. Lots 1 and 2 were in good shape to be sold as feeder hogs, while the pigs in lot 3 were about 25 pounds too heavy to sell readily as feeders. It was observed during the pasturing season that the pigs in lot 1 spent more time grazing on alfalfa than pigs from the other two lots. The pigs in lot 3 spent the least time grazing and usually pastured only the alfalfa which was close to their quarters.

The feed cost per 100 pounds of gain was as follows: 148 pounds of corn in lot 1, 212 pounds of corn in lot 2, and 277 pounds of corn in lot 3. Table 36 shows the results for the pasturing period.

TABLE 36.—*Results of feeding spring pigs varying corn rations as a supplement to alfalfa pasture in 1921*

Items of comparison	Corn ration		
	Lot 1, 1 per cent	Lot 2, 2 per cent	Lot 3, 3 per cent
Number of pigs in lot	10	9	9
Length of test ....days	126	126	126
Dates of pasturing	June 2 to Oct. 6	June 2 to Oct. 6	June 2 to Oct. 6
Average initial weight ....pounds	35	33	34
Average final weight ....do	87	113	149
Average gain per pig ....do	52	80	115
Average daily gain per pig ....do	.41	.63	.91
Grain fed per 100 pounds of gain ....do	148	212	277

On October 6 the pigs from the three lots were divided as follows: Five pigs from each lot were turned into standing corn in three separate lots with 60 per cent tankage in self-feeders. The remaining five pigs from lot 1, four pigs from lot 2, and four pigs from lot 3 were put in three separate dry lots on full feed of shelled corn and 60 per cent tankage. The tankage was not available for the first six days of this finishing test. The shelled corn used in the dry lots was a good-quality yellow corn of the previous year's crop.

The pigs were on experiment in the cornfield and in the dry lots until each lot reached an average weight of about 200 pounds per pig. It was impossible to estimate accurately the quantity of corn used by pigs in the cornfield, so this item is not included in Table 37.

In the dry-lot feeding the pigs that had been given a 1 per cent ration on pasture proved to be the most efficient. They not only made their gains on less feed than the 2 and 3 per cent pigs but also made better average daily gains per pig.

Table 37 gives the results for the finishing experiment.

From Table 37 it would appear that the spring pigs that have been carried on alfalfa pasture on a restricted ration which has not been so small as to stunt them but enough to keep them growing with small daily gains made the best gains during the finishing period. However, the small daily gains of the 1 per cent pigs resulting in a

smaller size make them less profitable to the grower than pigs fed a 2 per cent ration. These attain a desirable feeder-hog weight of 100 pounds at the end of the pasturing season. The 3 per cent pigs are a little too heavy and too fat for the feeder-hog trade.

For the Corn Belt farmer the pigs weighing 100 pounds or less give the best results, since a pig of this size will put on 100 pounds or more of pork on cheap corn. A heavier pig may not pay, for the original cost is too high and not so much corn can be marketed on the hoof, these pigs reaching marketable weight sooner.

TABLE 37.—*Results of finishing spring pigs on standing corn in the field and in dry lots after pasturing 126 days on alfalfa supplemented by stated corn rations in 1921*

[The pigs of lots A, C, and E were finished on standing corn in the field supplemented by self-fed 60 per cent tankage. Lots B, D, and F were finished on full feed of corn and 60 per cent tankage in dry lots]

Items of comparison	Previous corn ration supplementing alfalfa pasture					
	1 per cent corn		2 per cent corn		3 per cent corn	
	Lot A	Lot B	Lot C	Lot D	Lot E	Lot F
Number of pigs used	5	5	5	4	5	4
Initial weight per pig ... pounds	86	88	112.5	113.5	151	145
Final weight per pig ... do	200	201	197	201	199	201
Length of test ... days	52	49	44	39	28	27
Daily gain per pig ... pounds	2.19	2.31	1.92	2.24	1.71	2.07
Feed eaten daily:						
Corn ... do	--------	7.4	--------	7.7	--------	7.5
Tankage ... do	.60	.80	.64	.67	.76	.77
Feed consumed per 100 pounds of gain:						
Corn ... do	--------	321	--------	341	--------	359
Tankage ... do	24	32	30	25	37	29

Table 38 shows the approximate feed cost exclusive of alfalfa pasture and hay in season to make a 200-pound hog; also the time required to grow a spring pig from birth to the weight of 200 pounds when varying grain rations are fed during the pasturing season.

TABLE 38.—*Feed cost to grow a spring pig from birth to a weight of 200 pounds when varying corn rations are fed on alfalfa pasture*

Items of comparison	Corn ration on alfalfa pasture		
	Lot 1, 1 per cent	Lot 2, 2 per cent	Lot 3, 3 per cent
Feed consumed during—			
Suckling period[1] ... pounds	150	150	150
Pasturing period ... do	77	169	318
Finishing in dry lot:			
Corn ... do	366	299	201
Tankage ... do	34	22	16
Total feed consumed:			
Corn ... do	593	618	669
Tankage ... do	34	22	16
Life history of pigs:			
Average date of birth	Mar. 24	Mar. 24	Mar. 24
Date weaned and put on pasture	June 2	June 2	June 2
End of pasturing and beginning of finishing period	Oct. 6	Oct. 6	Oct. 6
Date weight of 200 pounds was reached	Nov. 24	Nov. 14	Nov. 2
Time required for a spring pig to reach 200 pounds weight ... days	245	235	223

[1] The approximate feed expenditure for a 35-pound pig is figured on the basis of two litters per sow per year, with six pigs to the litter. The 150 pounds of feed represents one-sixth of the grain consumed by a sow during the gestation and suckling periods plus the grain consumed by a pig in the "creep."

The total cost of tankage when shipped in small lots to Newell, S. Dak., is usually three times the cost of shelled corn. Figuring a pound of tankage as 3 pounds of corn the total feed cost of a 200-pound pig (excluding alfalfa pasture and hay in season) would be 695 pounds in lot 1, 684 pounds in lot 2, and 717 pounds in lot 3. (Table 38.)

The extremely cheap gains of the pigs in lot 1 on alfalfa pasture were offset later on in dry-lot feeding in a longer finishing period. The pigs in lot 2 receiving a medium ration on pasture made their 200 pounds weight on less grain than lots 1 or 3. The pigs in lot 3 receiving the most liberal ration on pasture also consumed more grain per pound of gain while finishing off; however, they were ready for market 12 days earlier than the pigs in lot 2 and 22 days earlier than the pigs in lot 1.

HOGGING CORN

An experiment was planned to compare the results of hogging off corn alone with the use of supplemental pastures and to determine the relative values of alfalfa and soybeans as such supplement.

Purebred Duroc-Jerseys were used, 27 pigs being divided into lots as follows:

Lot 1, 7 pigs averaging 87 pounds, hogging corn alone.
Lot 2, 10 pigs averaging 85.5 pounds, hogging corn and soybeans.
Lot 3, 10 pigs averaging 85.5 pounds, hogging corn and alfalfa pasture.

The pigs in lot 1 hogged off the corn in 28 days, making an average daily gain of 1.39 pounds at an estimated cost of 4.76 pounds of corn per pound of gain.

The pigs in lot 2 hogged off the corn in 36 days, making average daily gains of 1.57 pounds at an estimated cost of 4.67 pounds of corn per pound of gain. For the first two weeks they refused to eat any soybeans. Later they ate some of the leaves which were rapidly drying up. At the end of the test a good percentage of the soybeans was left untouched by the pigs.

TABLE 39.—*Results of hogging corn*

Items of comparison	Hogging corn alone	Hogging corn and soybeans	Hogging corn and alfalfa pasture
Dates of tests	Sept. 15 to Oct. 13	Sept. 15 to Oct. 21	Sept. 15 to Oct. 23
Length of test ... days	28	36	38
Number of pigs in the lot	7	10	10
Average initial weight per pig ... pounds	87	85.5	85.5
Average final weight per pig ... do	126	142	148.5
Average gain per pig ... do	39	56.5	63
Average daily gain per pig ... do	1.39	1.57	1.66
Estimated yield of corn in lot ... bushels	23.1	47.1	40.7
Estimated corn eaten per pound of gain ... pounds	4.74	4.67	3.62
Net returns per bushel for corn	$1.00	$0.97	$1.15

The pigs in lot 3 made their corn last longer than in the other two lots. They finished in 38 days, making average daily gains of 1.66 pounds, which was better than the pigs in the other two lots, at an estimated cost of 3.62 pounds of corn per pound of gain. This cost was the lowest of the three lots.

At the conclusion of the test the pigs were sold at local yards as heavy feeders at 8½ cents per pound. After deducting the cost of soybean seed in lot 2 and the charges for alfalfa pasture used in lot 3, the pigs returned $1 a bushel for the corn in lot 1, 97 cents per bushel in lot 2, and $1.15 per bushel in lot 3.

Previous to hogging the corn the pigs were used in pasturing alfalfa with limited daily rations of corn. During the first few weeks of the hogging-off test the pigs in lots 1 and 2 could often be seen looking for alfalfa plants through the woven-wire fence. Observations at this farm indicate that protein supplements, such as rape and soybeans, do not seem to interest pigs that have previously had access to good alfalfa pasture. Table 39 shows the results of hogging corn.

A charge of $2.50 is allowed for 35 pounds of soybean seed and in the pasture lot a charge of $3 for alfalfa. The gains are figured at 8½ cents per pound, the actual selling price at local yards at the time this experiment was closed.

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